

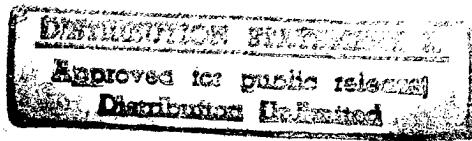
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29 MARCH 1991



# *JPRS Report*

# Science & Technology

*USSR: Life Sciences*



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# Science & Technology

## USSR: Life Sciences

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### Features of Optokinetic, Optocolomotor and Vestibulooculomotor Responses in Weightlessness

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[Article by L. N. Kornilova and G. Bodo, Department of Physiology of Analyzer Systems, Institute of Biomedical Problems, USSR Ministry of Health; and ENT Department, Central Hospital of the Hungarian People's Army]

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[Text] It is generally believed that information received via the vestibular channel is the main source of formation of perceptive, sensorimotor and autonomic disturbances in weightlessness, since its input is a mechanoreceptor that has been geared through evolution to function in a gravity field.

The condition of the vestibular system and of the characteristics reflecting the patterns for implementation of vestibular signals in perceptive, sensory, sensorimotor and autonomic systems during the first three days in weightlessness were virtually unstudied before 1984, except for the first studies of oculomotor activity in cosmonauts during missions aboard the Vostok-3, Vostok-4, Vostok-5 spaceflights<sup>1</sup> and systematic studies of preflight and postflight vestibular functions.<sup>4, 9</sup>

Implementation in the last few years of Soviet programs of investigation of vestibular function in weightlessness (the Primat experiment aboard Kosmos-1514 and Kosmos-1667<sup>12</sup> and the Optokinez experiment aboard the Soyuz-T/Salyut-7 complex,<sup>5, 6, 10</sup>) and of the American-European Shuttle and Shuttle-Spacelab programs<sup>7, 8, 15, 16</sup> have substantially augmented the information about the characteristics and functional patterns of the vestibular system and about the features of its interaction with other afferent inputs under such conditions.

Our objective here is to present the results of a study of optocolomotor and vestibulooculomotor responses in weightlessness during the Optokinez experiment, which was carried out in 1984 during the seven-day mission of the Soviet-Indian crew and during the 237-day mission aboard the Salyut-7 station.

The objectives of the experiment were to study spontaneous oculomotor activity and the effect of optokinetic stimulation (OKS) on it; assess fixational rotation and tracking movements of the eyes; determine threshold and above-threshold sensitivity of oculomotor function to graded OKS in different directions; assess vestibulooculomotor responses to primarily otolithic stimulation (rocking the head in the frontal plane) and ampullar stimulation (rotating the head about the longitudinal axis); assess the effect of active head movements on optocolomotor responses; and investigate adaptation of sensory systems to weightlessness from oculomotor responses to vestibular stimulation and OKS.

The OKS program, which was taped on a videocassette with the Hungarian Oking instrument, included display on a 20° television screen of a single 0.5° visual stimulus that moved 20 times in different directions at a frequency of 1 Hz; as well as black-and-white bands (each about 2° in size) moving at speeds of 1 - 20°/sec horizontally, vertically and diagonally for 15 s in each direction.

Adequate vestibular stimulation was provided by continuous rocking of the head in the frontal plane (from the right shoulder to the left, over about 90°) at a frequency of 1 movement per second for 1 minute; or else, by continuous rotation of the head about the vertical axis (from right to left through about 90°) at the rate of 1 rotation per second for 1 minute.

The Optokinez experiment, a schematic of which is presented in Figure 1, involved recording the following: Spontaneous eye movements when looking straight ahead and during extreme movements of eyeballs; fixational turns and tracking movements of the eyes; lower and upper thresholds of optokinetic nystagmus (OKN); eye movements in predominantly otolithic stimulation (rocking head in frontal plane); tracking eye movements, then lower and upper thresholds of OKN following vigorous rocking of the head; eye movements in predominantly ampullar stimulation (head rotation about longitudinal body axis); tracking eye movements, upper and lower OKN thresholds after vigorous head rotation.

Oculomotor responses to optomotor and optokinetic stimuli were recorded with head in fixed position.

Analysis of oculograms for optomotor stimuli determined tracking efficiency coefficients (ratio of frequency of oculomotor responses to frequency of delivery of visual stimulus), phase correlation coefficient (ratio of time intervals between input signals and intervals of eye responses), amplitude of saccades, slow tracking phase rate, and asymmetry of responses.

Analysis of nystagmograms for optokinetic stimuli determined frequency and amplitude of nystagmus, asymmetry of responses, and magnitude of rate of visual stimuli at which nystagmus appears and disappears.

The oculogram taken with vestibular stimulation (head rocking and rotation) was evaluated in terms of the nature and quality of the trace of the sinusoidal curve (smooth, multi-peaked, presence or absence of nystagmic eye movements).

The experiment was carried out with the onboard Aelita complex. The studies aboard the station were carried out by cosmonaut-physician O. Yu. Atkov during the seven-day mission (on the 2nd and 5th days of weightlessness) and in one crew member of the 237-day mission (on the 5th, 9th, 52nd, 116th, 169th, and 200th days), as well as before and after the missions: on the 2nd and 5th days after the seven-day mission, and on the 2nd, 5th, 14th and 75th days after the 237-day mission.

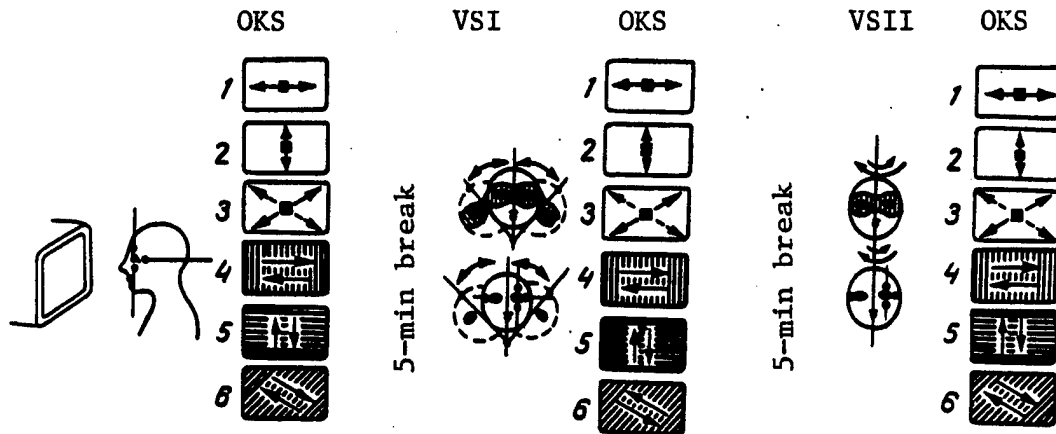


Figure 1. Schematic of Optokinez experiment

Key: OKS—program of visual stimuli: 1, 2, 3—optoculomotor stimuli: 4, 5, 6—optokinetic. Arrows show direction of stimulus movement. VS—vestibular stimulation: I—rocking of the head with open eyes, with and without dark glasses; II—head rotation with open eyes, with and without dark glasses

No preflight signs of vestibular dysfunction were found in the subjects. When the position of the body was changed in space and the eyeballs were moved to extreme positions, no nystagmus was recorded, the position of the eyeballs was stable, and isolated microsaccadic movements of the nystagmic and square-wave type were observed.

There were no corrective microsaccades during fixational turns of the eyes and tracking. Saccade amplitudes were stable ( $M = 19.1 \pm 0.4^\circ$ , range of variation  $2^\circ$ ). The tracking efficiency coefficient and phase correlation coefficient were in the range of 0.9 - 1.1.

The lower threshold of optokinetic nystagmus corresponded to a 5 - 6°/sec OKS rate, and the upper threshold, to a 20°/sec rate. The optokinetic reflex and optoculomotor responses were virtually symmetrical ( $K_a \leq 5$  percent).

Rocking the head to the beat of a metronome through a 90° angle at a frequency of 1 Hz for 1 minute, with the eyes open, with and without dark glasses produced a distinct sinusoidal curve that characterized compensatory counterrotation of the eyes. Rotation of the head about the longitudinal body axis, with the subject wearing dark glasses also produced a sinusoidal curve, but when the eyes were open without glasses, the oculogram was multipeaked.

Vestibular stimulation in the form of vigorous rotation or rocking of the head (which represent a complex set of movements) increased the amplitude of saccades of the oculomotor response to optomotor stimuli and led to the appearance of corrective saccades in the compensatory tracking phase.

Eye movements that were recorded in a relaxed state on the 2nd day of flight in weightlessness (with the eyes open without glasses and with lightproof glasses)

revealed an increase in spontaneous oculomotor activity of the saccadic and floating type in two subjects, and in the form of a nystagmic response in one (Figure 2).

There were also considerable inflight changes in oculomotor tracking function when stimuli moving in different directions were observed, and they were the most marked when stimuli moving vertically or diagonally were being tracked (Figure 3).

The tracking efficiency and phase correlation coefficients diminished substantially in flight (0.4 - 0.6), and saccade amplitude diminished ( $M = 14.1 \pm 0.9^\circ$ ) and lost its stability (range of variation  $8^\circ$ ). Additional corrective saccades appeared in the slow tracking phase (compensatory deflection of the eyes in the direction of stimulus movement), and in a number of cases there was a superimposed nystagmic response.

Examination on the 5th day of the flight revealed stabilization of eyeball position in two subjects. One subject had floating eye movements, to which was added microsaccadic activity of the square-wave type on the 169th day. The nature of the tracking of a single stimulus moving in different directions reverted to virtually the preflight level in all subjects on the 5th day.

In the initial period of adaptation to weightlessness, there were also changes in oculomotor responses to vestibular stimulation (see Figure 3). If, before the flight, vestibular stimulation in the form of vigorous rotational or rocking movements of the head increased the amplitude of the oculomotor response to optomotor stimuli and led to the appearance of corrective saccades, then during the flight the same stimuli compensated, as it were, for the inadequacy of vestibular input in two subjects, normalizing oculomotor function; in another, however, they disorganized it completely. On the 5th day of the flight in weightlessness, vestibular stimulation had virtually no effect on the nature of optoculomotor responses.

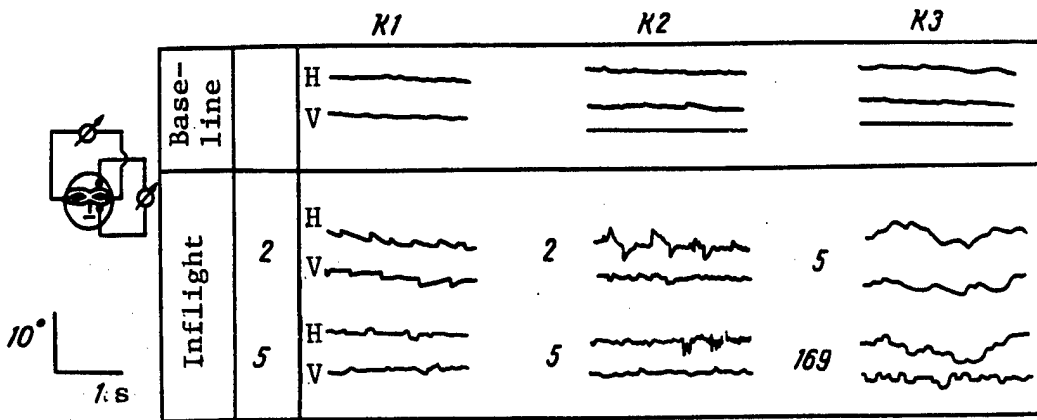


Figure 2. Types of oculomotor activity (with dark glasses worn, with the eyes open)

Key: K1, K2, K3—cosmonauts being tested; 2, 5, 169—day of flight. Here and in figures 4 and 5: H is horizontal and V is vertical lead of electrooculogram

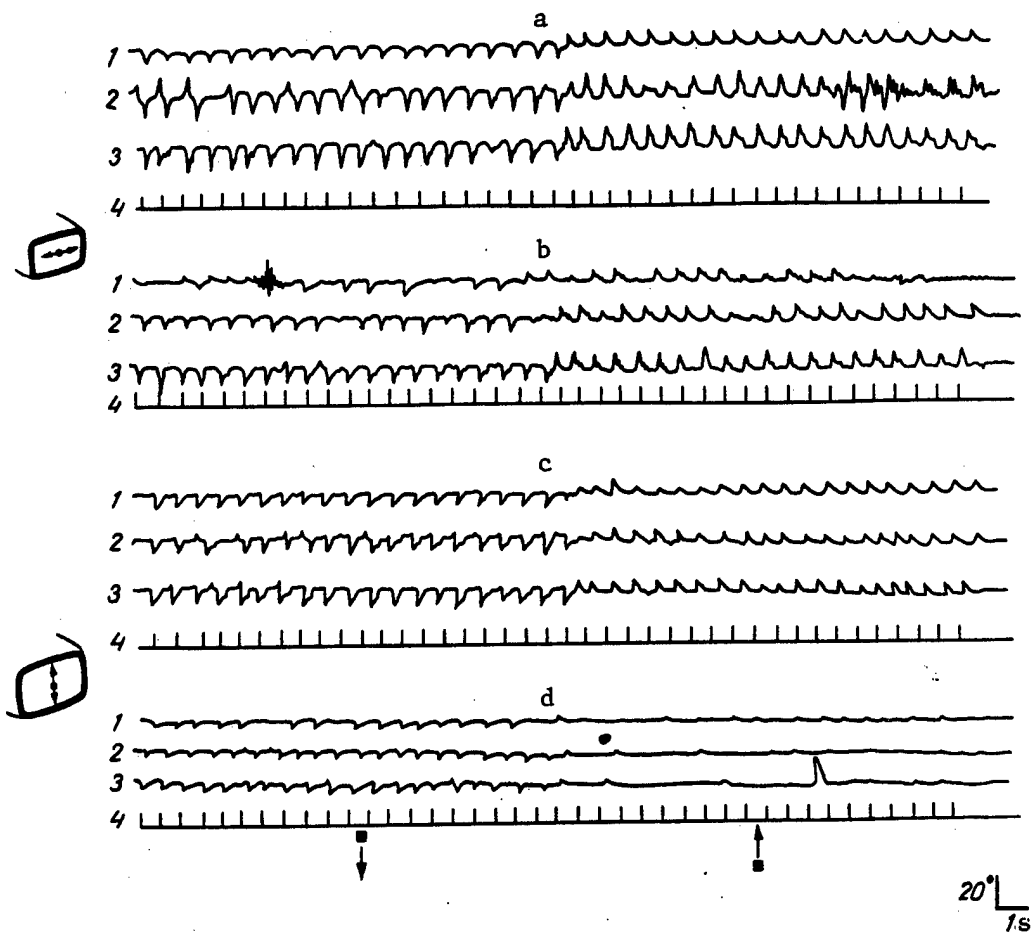


Figure 3. Electrooculograms (EOG) of tracking function

Key: a, b—tracking of horizontally moving stimulus; c, d—tracking of vertically moving stimulus; a, c—preflight data; b, d—inflight data (2nd day); 1, 2, 3—EOGs when visual stimulus was tracked before vestibular stimulation, after rocking of the head, and after rotation of the head, respectively; 4—point at which stimulus is introduced. Arrows indicate direction of stimulus movement. Calibration 20°, 1 sec.



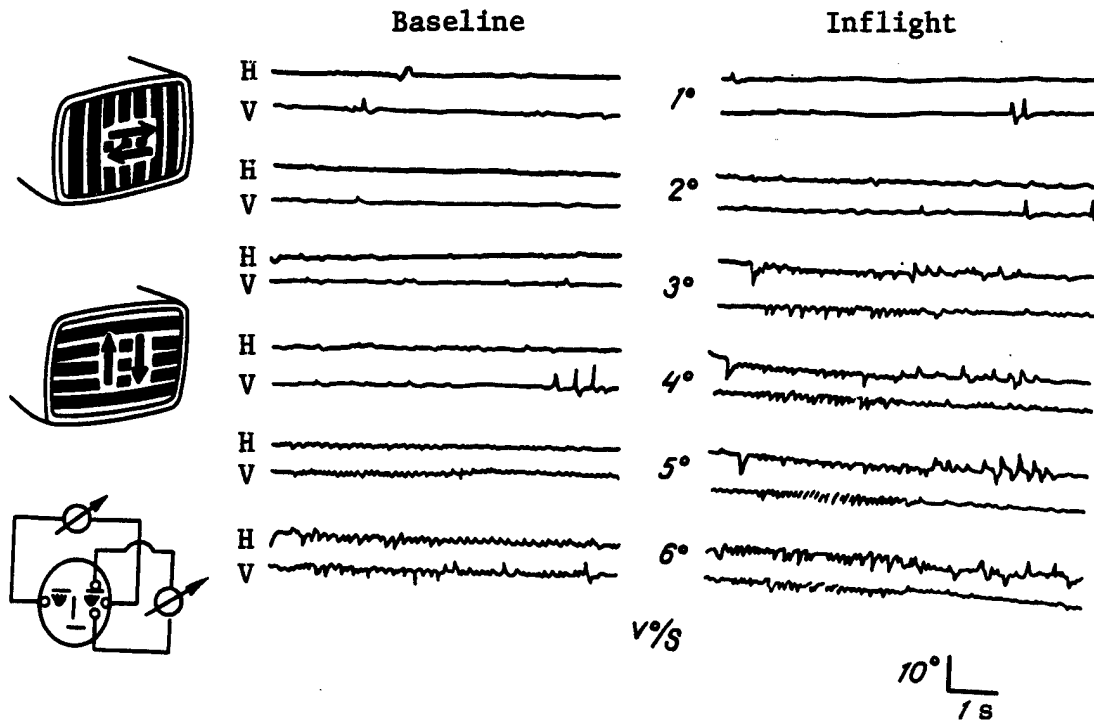


Figure 4. Lower threshold of retinal optokinetic nystagmus before and during (2nd day) flight

Key: V°/S—rate of movement of optokinetic stimuli (in degrees per second). Calibration 10°, 1 sec.

Investigation of the lower and upper thresholds of the optokinetic reflex in flight revealed their distinct decline in all subjects (Figure 4). In weightlessness, the lower threshold was 2 - 3°/sec and the upper, 9 - 10°/sec. The lowering of optokinetic reflex thresholds persisted in all subjects on subsequent days of the mission.

It must be noted that testing of both the optokinetic reflex and optoculomotor responses inflight revealed distinct asymmetry of oculomotor responses to stimuli moving in different directions ( $K_a = 50 - 80$  percent).

Oculomotor response to adequate vestibular stimulation (Figure 5) also changed. Testing on the 2nd and 5th days of the flight showed that the compensatory otolithic response of counterrotation of the eyes when the head is rocked with the eyes shut did not disappear, but was merely somewhat milder and appreciably slower, judging by the electrooculogram trace (absence of pauses), and it was accompanied by low-amplitude ( $A = 2 - 4^\circ$ ) nystagmus. On the 2nd and 5th days, rocking the head with the eyes open produced complete destabilization of the eyes in one subject and high-amplitude ( $A = 7 - 10^\circ$ ) nystagmic beats in two subjects. When the head was rotated with the subject wearing glasses, oculograms of two subjects revealed isolated nystagmic beats; when their eyes were open without glasses, there was distinct nystagmus.

Thus, inflight studies of oculomotor function in the Optokinez experimental program enabled us, for the first

time, to assess objectively, and record quantitatively, changes in the system of vestibulooculomotor interaction that were indicative of, on the one hand, increased dynamic excitability of visual and vestibular inputs (lowering of thresholds of optokinetic and vestibular nystagmus) and, on the other hand, of diminished static vestibular excitability (lower amplitudes and disappearance of saccades during tracking of a single moving stimulus with fixed head position), in spite of the subjective absence of symptoms of space motion sickness (discomfort, nausea, etc.) in the subjects. Weightlessness conditions not only affect the function of receptor elements of the vestibular analyzer, but also change conditions for reception and transmission of sensory signals and for their processing on all levels of the central nervous system.

The changes observed in weightlessness in tracking eye movements can, according to the concepts of clinical vestibulology, be related to involvement of the stem and cerebellar levels of the CNS and with disorganization of pontovestibulocerebellar interactions and vestibulocerebellar relations.<sup>11, 13, 14</sup>

The floating eye movements recorded in weightlessness apparently reflect changes in the level of functioning of central elements of the brain—reticular formation of the mesencephalon and cerebral cortex.<sup>2</sup> It is necessary to

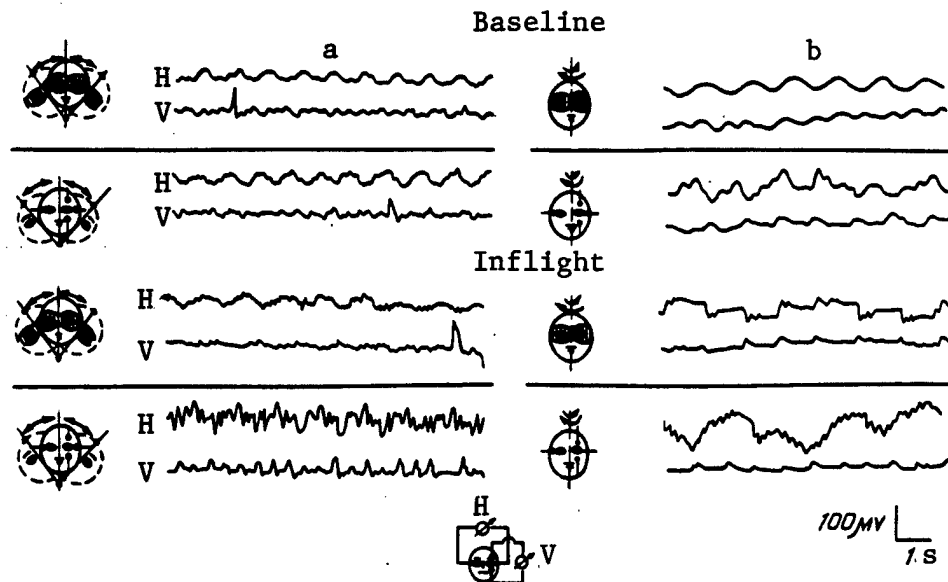


Figure 5. Nature of EOG during vigorous head movements before and during flight (2nd day)

Key: a—head rocking in frontal plane; b—head rotation about longitudinal axis with eyes open with and without dark glasses, without eye fixation. Calibration 100 mV, 1 sec.

also take into account the loss of reference in weightlessness and proprioceptive deprivation, which also modulates the tested responses in a specific way.<sup>3</sup> The decrease in proprioceptive activity, which changes the functional level of vestibular nuclei and activating structures of the mesencephalon, may have a specific bearing on the change in vestibular excitability. On the other hand, under such conditions, there is also a decrease in inverse corticofugal flow, as well as in inhibitory effects from the cortex on subcortical structures, which could also lower thresholds of sensory responses.

Unquestionably, one cannot fail to also take into consideration the role of weightlessness-induced changes arising in blood and spinal fluid dynamics, which alter the nature of vestibular responses in weightlessness.

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### Expression in Escherichia Coli of $\gamma$ -Subunit Gene of cGMP Phosphodiesterase of Outer Segments of Bovine Retinal Rods

907C0779A Moscow *BIOLOGICHESKIYE MEMBRANY in Russian Vol 7 No 3, Mar 90*  
pp 230-242

[Article by N. P. Skiba, I. P. Udovichenko, V. A. Bondarenko, M. Yu. Natochin, A. A. Yurovskaya, S. A. Zozulya, Ye. P. Shirokova, and V. M. Lipkin, Pushchino Branch of the Institute of Bioorganic Chemistry imeni M. M. Shemyakin, USSR Academy of Sciences, Moscow Oblast]

UDC 577.213.7:577.354.25:577.152.31:575.177.2

[Abstract] Recombinant  $\gamma$  ( $\gamma$ ) subunit of cGMP phosphodiesterase of the outer segments of bovine retinal rods was obtained in an Escherichia coli system bearing plasmid vector pTIS1P containing the  $\gamma$  gene, Pr promoter of bacteriophage  $\lambda$ , and a synthetic ribosome recognition sequence. Western blotting was used for detection of  $\gamma$  production, which was produced by proteinase deficient E. coli lon<sup>-</sup> cells in which the basic product escaped proteolytic degradation. Maximum expression of the  $\gamma$  gene was detected 30 min after incubation at 42°C, with the level of synthesis reaching 0.05 percent of total cellular protein.  $\gamma$  was shown to inhibit trypsin-activated cGMP phosphodiesterase activity and to bind the  $\alpha$  subunit of transducin in solid-phase enzyme-linked assays. Figures 8; references 30: 3 Russian, 27 Western.

### Interaction of Autoliposomes With Tumor Cells

907C0779C Moscow *BIOLOGICHESKIYE MEMBRANY in Russian Vol 7 No 3, Mar 90*  
pp 289-296

[Article by V. Yu. Bekreneva, A. G. Zhuykov, A. A. Shaldzhyan, Yu. S. Reznikovskiy, and O. A. Rozenberg, Central Scientific Research Institute of Diagnostic Radiology, USSR Ministry of Health, Leningrad]

UDC 616-006:612.015.3

[Abstract] The development of liposomes as drug delivery vehicles led to a comparative analysis of the interaction of autoliposomes and monolamellar phosphatidyl:cholesterol liposomes (PCL) with ascitic Ehrlich carcinoma and ascitic lymphoma NKLy/LL cells. The results demonstrated that the tumor cells bound two to three times as many autoliposomes as they did PLCs, due to a greater number of binding sites on the cells for the former. In addition, autoliposomes and PLCs were shown to bind to different sites, a fact attributed to the presence of membrane proteins in the autoliposomes, identified as 63 and 71 kD glycoproteins. Binding studies with NLKy/LL cells showed equivalent binding of autoliposomes and liposomes prepared from Ehrlich tumor cell components, regardless of the cell source.

Consequently, the aqueous contents of the autoliposomes were transferred to the tumor cell three times as efficiently as from PLCs. The study demonstrated the importance of the cell membrane glycoprotein component in efficient binding of autoliposomes to target cells and, thus, internalization, both of which are important in drug delivery. Figures 3; tables 5; references 26: 11 Russian, 15 Western.

### Molecular Organization and Biological Properties of Yersinin, a Porin From *Yersinia Pseudotuberculosis*

907C0818 Moscow *BIOLOGICHESKIYE MEMBRANY in Russian Vol 7 No 5, May 90*  
pp 453-461

[Article by O. D. Novikova, G. N. Likhatskaya, G. M. Frolova, O. P. Vostrikova, V. A. Khomenko, N. F. Timchenko, T. F. Solovyeva and Yu. S. Ovodov, Pacific Ocean Institute of Bioorganic Chemistry, Far Eastern Division of USSR Academy of Sciences, Vladivostok]

UDC 579.842.23:577.112\*314.6

[Abstract] Recently, it was shown that "cold" *Yersinia pseudotuberculosis* bacteria, in contrast to "warm" *Y. pseudotuberculosis*, contain a polypeptide zone which, by its molecular weight, appears to be an oligomer of yersinin; furthermore, yersinin is an active component of the bacterial membrane facilitating the adhesion and penetration of the pseudotuberculosis bacteria into epithelial cells *in vitro*. The goal of the work reported here was to investigate the antigenic structure, pore-forming properties, and biological activity of yersinin, a porin of *Y. pseudotuberculosis* cultivated at various temperatures. During the first phase of this study it was shown that extraction of "cold" microbial cells with SDS yielded the oligomeric form of yersinin, while principally from the "warm" cells the monomeric form was obtained. Lowering the cultivation temperature of the microbe resulted in higher relative content of the aggregated porin form. Immunochemical studies showed that the antigenic structure, and hence the molecular organization, of porin in the peptidoglycane proteins of the "cold" bacteria differs from that of the "warm" bacteria. The oligomeric form of porin was viewed as one factor of the virulence of the pseudotuberculosis microbe, and it was concluded that porins play an important role in the development of the infectious processes. Figures 5; references 25: 10 Russian, 15 Western.

### Physiological Mechanisms of Antihypoxic Action of Liposomes

917C0066A Leningrad *FIZIOLOGICHESKIY ZHURNAL SSSR IMENI I. M. SECHENOVA in Russian Vol 76 No 7, Jul 90* pp 897-902

[Article by V. P. Pozharov, T. D. Minyaylenko, A. V. Stefanov, S. A. Bryginskiy, M. M. Seredenko and V. K. Lishko, Department for Studies on Hypoxic States,

Institute of Physiology imeni A. A. Bogomolets and Liposome Laboratory, Institute of Biochemistry imeni A. V. Palladin, Ukrainian SSR Academy of Sciences, Kiev]

UDC 612.273+612.015.1

[Abstract] The demonstration showing intravenous introduction of liposomes enhances tolerance of hypoxia led to the present assessment of the physiological correlates underlying such benefits. Studies on 200 - 250 g Wistar rats involving inhalation of a 7 percent oxygen mixture for 90 min and i.v. administration of liposomes 30 min from the start of inhalation in a dose of 2.5 mg of lipid/100 g showed that liposome administration

improved oxygen supply and alleviated tissue hypoxia. Improvement was largely attributed to enhanced diffusion of oxygen across biological barriers, attenuation of free-radical processes, and diminished accumulation of underoxidized metabolic products and lipid peroxides. Concomitant changes included increased efficiency of pulmonary ventilation and gas exchange. Improvements in tissue oxygenation were unrelated to tissue liposome deposition, which tended to favor the RES (i.e., liver, spleen), since essentially similar oxygenation was noted in organs with minimal liposome ingress (heart, lungs), or trace liposome levels (brain). Accordingly, the beneficial effects of liposomes in hypoxic states appears to be secondary to a more basic mechanism. Tables 4; references 14: 12 Russian, 2 Western.

**Bionic Model of Active Electrolocation in Fish**

907C0732B Moscow DOKLADY AKADEMII NAUK  
SSSR in Russian Vol 311 No 4, Apr 90 pp 984-988

[Article by Yu. B. Shaub and A. V. Khodzevich, Pacific Oceanologic Institute, Far Eastern Department, USSR Academy of Sciences, Vladivostok]

UDC 551.46.07:591.512

[Abstract] Currently, description of electrolocation in fish has been largely qualitative. The essential feature of this phenomenon is that a pulsatile field is generated around the fish; distortions in the field by an object with a different conductivity than that of water and their perception by specialized receptors forms the basis of electrolocation. Accordingly, a mathematical rationale is provided for a bionic model for active electrolocation, which encompasses such parameters as generation of the primary field, detection of reflected signals, and information processing to derive data on target coordinates. Accordingly, a series of eight equations were derived for determination of the x, y and z coordinates of the target object and the modulus of the dipole moment. Figures 3; references 7: Russian.

**Galvanostatic Photopotential of Chlorophyll and Carotene Films**

907C0754A Moscow BIOFIZIKA in Russian Vol 35  
No 2, Mar-Apr 90 pp 197-199

[Article by Yu. S. Shumov, Institute of Chemical Physics imeni N. N. Semenov, USSR Academy of Sciences, Moscow]

UDC 577.3

[Abstract] Chlorophyll-a and  $\beta$ -carotene films on platinum substrate showed an increase in photopotential when polarized by a constant current from a galvanostat.

The increase in the galvanostatic photo-electromotive force between the chlorophyll and the carotene electrodes was more than ten-fold greater than the photo-electromotive force seen with an open circuit and approached approximately 0.9 V. The latter was sufficient for electrolysis of water. The galvanostatic and Becquerel's potentials are the result of polarization of the substrate by continuous and catalytic photocurrents in the film, with the sign of the current depending on the type of film conductivity involved. Figures 1; references 6: Russian.

**Isolation and Comparison of Two Fluorescent Flavoproteins of Luminous Bacteria Photobacterium Leignathi**

907C0754B Moscow BIOFIZIKA in Russian Vol 35  
No 2, Mar-Apr 90 pp 368-370

[Article by A. A. Raybekas and V. N. Petushkov, Institute of Biophysics, Siberian Division, USSR Academy of Sciences, Krasnoyarsk]

[Abstract] In order to define the primary substrate of luciferase in *Photobacterium leignathi*, extraction was conducted which led to the isolation of two fluorescent flavoproteins, designated FFP (fluorescent flavoprotein) and GFP (green flavoprotein). The fluorescence spectra of both proteins were identical, although the fluorescence of FFP was approximately 500 times more intense. Absorption spectra following dithionite reduction were also similar, with a maximum at 312 nm. In addition, FFP was shown to be a monomer with a molecular weight of 20 kD, and GFP a dimer with a molecular weight of 54 kD. Studies on the replacement of FMN by FFP and GFP in in-vitro luciferase reactions showed that both isolates were effective, but that fluorescence with FFP was six times more intense than with GFP. Accordingly, these findings indicate that FFP serves as the substrate for bacterial luciferase in vivo. Figures 3; references 1: Russian.

**Electrofusion of Selected Pairs of Tobacco Protoplasts**

907C0743A Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR: SERIYA B—GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 6, Jun 90 pp 74-77

[Article by I. V. Kirichenko, Department of Cell Biology and Engineering, Institute of Botany, Ukrainian SSR Academy of Sciences, Kiev]

UDC 578.085

[Abstract] Conventional techniques of electrofusion were used for selected pairs of *Nicotiana tabacum* and *N. plumbaginifolia* protoplasts, yielding a fusion success rate of ca. 90 percent in NT + NT and NT + NP combinations. The rate of plant regeneration from the resultant microcolonies was on the order of 20 - 30 percent. Electrofusion was accomplished with 50  $\mu$ m diameter platinum microelectrodes with an interelectrode space of 200 - 400  $\mu$ m, and right angle 14 - 20 V impulses delivered from ESL-2 stimulator fed by L-31 generator to create a 5 - 10 V dielectrophoresis potential. Figures 5; tables 1; references 14: 1 Russian, 13 Western.

**Cultivation of Protoplasts of Four Species of Apocynaceae Family**

907C0819 Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR: SERIYA B—GEOLOGICHESKIYE, KHIMICHESKIYE I BIOLOGICHESKIYE NAUKI in Russian No 7, Jul 90 pp 80-83

[Article by I. A. Kostenyuk, O. F. Lyubarets, and UkSSR Academy of Sciences Academician Yu. Yu. Gleba, Department of Cellular Biology and Engineering, Institute of Botany, UkSSR Academy of Sciences, Kiev]

UDC 578.085

[Abstract] Several dogbane family representatives (Apocynaceae)—*Rauwolfia*, *Catharantus*, *Vinca*, etc—are the sources of highly effective hypotensive and cytostatic preparations. Four species of the family were isolated and cultivated to produce stable, viable protoplast cell lines starting with callus cultures of *Rauwolfia serpentina*, *Rhazya stricta*, *Catharantus roseus* and young sterilized leaves of intact *Vinca* minor plants. Optimal cultivation conditions were developed for each species. Somatic hybrids between individual species of this family were obtained. Cultivation of the protoplast themselves was difficult because of their low viability (slow synthesis of the cell walls, low division rate and massive necrosis of the protoplast and cells during the first 5 - 8 days), while the callus obtained from such protoplast exhibited excellent growth characteristics. Figures 3; references 15: 3 Russian, 12 Western.

### Characteristics of Technogenic Pollution of the Belorussian Natural Environment on the Basis of Snow Cover Acidity

907C0748A Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 34 No 7, Jul 90 pp 646-648

[Article by Ye. A. Sidorovich, corresponding member BSSR Academy of Sciences, A. I. Alekhno, Ye. G. Busko, and N. I. Pikulik, Central Botanical Garden, BSSR Academy of Sciences; first paragraph is verbatim DOKLADY AKADEMII NAUK BSSR English abstract]

UDC 581.5

[Text] The data and graphic material on the snow cover acidity over Belorussian territory during the peak snow-melt are given. The territory of the republic is divided into four zones according to the pH level in KCl.

In the past decades scholars and communities throughout the entire world have paid special attention to the problem of acid rain. At the International Conference on the Problem of Acid Rain and Measures Being Taken to Combat It, which was held in 1986 in Amsterdam, it was noted that the main consequences of industrial pollution of atmospheric air are the death of forests, reduction in soil fertility, degradation of water sources, and deterioration of the health status of the population and animal kingdom.<sup>1</sup>

The acid nature of precipitation is determined primarily by the entry into the atmosphere of a number of products from the burning of fossil fuel and industrial enterprises' emissions of toxic ingredients such as sulfur, nitrogen, and metal compounds that form acid compounds when they react with water vapors and solid precipitation. Their acidity is directly proportional to the chemical makeup of atmospheric air.

In winter the crystalline elements of precipitation enter the atmosphere much more slowly than do those of liquid precipitation because they have a larger adsorption surface. A significant source of change in the chemical makeup of the snow cover is its pollution which occurs as a result of the settling of soot and ash and the accumulation of gaseous compounds. Consequently, as a number of researchers<sup>2-4</sup> indicate, the chemical makeup of the snow cover is a convenient object for assessing the qualitative state of the natural environment.

The pH value in atmospheric precipitation is one of the physicochemical indicators that make it possible to judge its ingredient makeup and, to some extent, to judge the nature of the latter. To some degree, this makes it possible to map out specific steps in performing the task of assessing the state of the natural environment of an individual region of Belorussian territory.

In configuring sampling points, we use the random sampling method; the use of this method ensured interpolation of the research results with an error not exceeding 10 percent.<sup>5</sup> On the basis of this principle, the

republic's territory was divided into 72 basic squares 60 km on a side. These were in turn divided into 100 pools 6 km on a side. Five points were established in each basic square. At these points, snow samples were taken (the sampling was repeated five times) during the period of maximum snow accumulation (March 1986 and again in March 1988). Analytical research was performed on an OR-211/1 pH-meter. A type EM1X-XT graph plotter was used to plot the skeleton maps.

The resultant research materials made it possible to conclude that in regions in which a number of chemical enterprises and heat and power units were concentrated (the cities of Grodno, Gomel, Mozyr, Svetlogorsk, Bobruysk, Novopolotsk), the sulfur, nitrogen, and heavy metal compounds entering the atmosphere give the snow cover an acid reaction with a pH of 3.3 - 4.0, which has a negative effect on the growth and development of plants (Figure 1). This conclusion is confirmed by experiments conducted by S. M. Adams and coworkers<sup>6</sup> on seedlings of a number of ligneous plants. The death of epidermal cells and a significant reduction of intercellular spaces in the leaf apparatus upon the effect of acid rain with a pH of 3.5 were noted.

As the distance from the republic's industrial centers increases, there is a gradual reduction in the entry of toxicants into the surrounding space until a pH of 4.1 - 4.8. In a significant portion of the republic's territory the snow cover has a weakly acid reaction with a pH of 4.9 - 5.6, and only individual regions have a pH of 5.6 or higher, which is explained by the alkalinizing capability of the Ca<sup>2+</sup> and Mg<sup>2+</sup> ions coming from enterprises producing construction materials.

The research conducted makes it possible to conclude that a spotty, ambiguous pattern of the distribution of acid rain in the snow cover is observed in the region's territory. It depends on the location of large industrial enterprises and heat and power units and the amounts of sulfur and nitrogen compounds and other pollutants discharged by them.

Climate factors play an important role in the distribution of acidity in solid precipitation in the republic's territory. Such factors are the thermodynamic properties of the atmosphere's stability in the research region, its temperature gradient, and the velocity and direction of the motion of air masses over the region's territory.

This methodological approach in research may be used during ecological monitoring of pollution of the natural environment of both individual territories and specific zones of large urban agglomerations in the republic.

#### Footnotes

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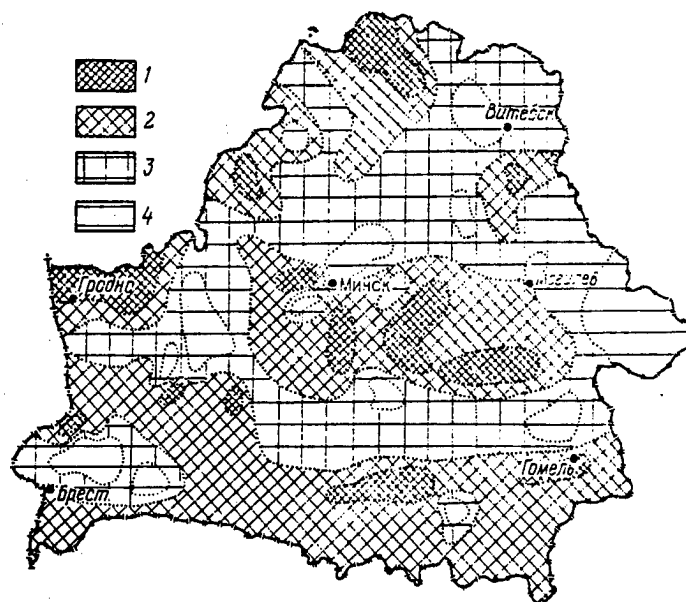


Figure 1. Acidity of the snow cover in the territory of Belorussia (pH in KCl): 1) 3.3 to 4.0; 2) 4.1 to 4.8; 3) 4.9 to 5.6; and 4) 5.6.

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**Natural Foci of Leptospirosis in Various Topographical-Geographical Zones of Carpathian Bukovina Area**

907C0799 Kiev VRACHEBNOYE DELO in Russian No 4, Apr 90 pp 116-117

[Article by V. N. Kondratenko and V. I. Dremlyuga, Laboratory of General Microbiology, Kiev Scientific Research Institute of Epidemiology and Infectious Diseases imeni L. V. Gromashevskiy]

UDC 616.986.7(477.8/35)

[Abstract] Until 1980, the incidence of leptospirosis in Bukovina territory was very low, with isolated cases being registered every 2 - 3 years. During the 1980 - 1987 period, the annual number of cases was recorded (incidence was 0.45 - 2.8 per 100,000 population). The rural population constituted 70 - 75 percent of all cases; 50 percent of the city people who contracted the disease did so while on vacations or on hunting or fishing trips in the country. Most of the cases (83.7 percent) were in the general area bordered by the Prut and Dniester rivers. Field studies identified natural foci of leptospirosis in the area with numerous lakes and rivers. Seven murine species were shown to be the carriers of antibodies to leptospirosis of the following serogroups: Grippityphosa (54.5 percent), Icterohaemorrhagiae (32.3 percent) and Pomona (12.3 percent). Natural foci of leptospirosis that are typical of locales with elevated moisture levels were identified for the first time ever in the Bukovina plain. The route of infection among the rodents was believed to be via water. References 8: Russian.

**Epidemic Manifestations of Natural Foci of Tick-Borne Encephalitis in Primorsk Territory. Communication 1. Pattern of Morbidity Distribution**

907C0854A Moscow MEDITSINSKAYA PARAZITOLOGIYA I PARAZITARNYYE BOLEZNI in Russian No 3, May-Jun 90 pp 9-12

[Article by G. N. Leonova and Ye. E. Borisovets, Scientific Research Institute of Epidemiology and Microbiology, Siberian Division, USSR Academy of Medical Sciences; Pacific Institute of Geography, Far East Division, USSR Academy of Sciences, Vladivostok]

UDC 616.831-002-022.7:578.833.26]-022.39-036.21(571.63)

[Abstract] The dynamics of tick-borne encephalitis morbidity distribution patterns in the Primorsk Kray from 1966 through 1987 and encompassing 1,035 cases were studied using computer maps generated on a yearly basis to trace changes in morbidity incidence and its cyclicity throughout the Primorsk Kray and in individual territories. It was shown that the Far East variant, which causes serious courses of the disease and has a high mortality rate, circulates in this area. The results demonstrated

that the Sikhote Alin mountain range has the highest incidence of tick-borne encephalitis in the Kray. In addition, although most of the Primorsk Kray has a low incidence of tick-borne encephalitis, there is a high degree of variation. The maps generated were used to create an atlas for public health agencies and to plan for prophylactic measures in this area. Figures 2; references 11: Russian.

**Isolation of Tick-Borne Encephalitis Virus Strains and Calculation of Immunity Prevalence Among Inhabitants and Animals of Northern Russian Valley**

907C0854B Moscow MEDITSINSKAYA PARAZITOLOGIYA I PARAZITARNYYE BOLEZNI in Russian No 3, May-Jun 90 pp 12-14

[Article by S. D. Lvov, V. L. Gromashevskiy, V. B. Semenov, V. P. Andreyev, T. M. Skvortsova, Ye. S. Fadeyev, E. R. Kanev, N. G. Sokolova, N. G. Kondrashina, P. I. Makhlin, G. V. Bogoyavlenskii, Ye. A. Gushchina, A. F. Farshatov, O. N. Andronova, and S. M. Klimentko, Scientific Research Institute of Evolutionary Morphology imeni N. F. Gamaleya, USSR Academy of Medical Sciences; Virology Institute imeni D. I. Ivanovskiy, USSR Academy of Medical Sciences, Moscow]

UDC 578.833.26.083.24+616.831-002-022.7:578.833.26]-078.333(470.11/13)

[Abstract] Field material consisting of mosquitoes, ticks, voles, mice, and other animals were collected in the tundra, forest-tundra, and northern and central taiga in Arkhangelsk and Komi Autonomous Soviet Socialist Republic in 1986-1987 with the purpose of isolating tick-borne encephalitis virus strains and calculating immunity to them. Two-day-old suckling mice infected with tick-borne encephalitis virus strains were used to prepare the antigen. Hemadsorption T-agglutinin test was employed to investigate the blood sera of people and animals. Eight strains were isolated, with three of them coming from rodents and five from ticks collected in the central taiga subzone. The results demonstrated that 0.6 percent of cows and 2.1 percent of people in the northern taiga subzone had antihemagglutinins to tick-borne encephalitis, while 4.9 percent of people in the central taiga subzone had tick-borne encephalitis antibodies. Although cases of tick-borne encephalitis are only sporadically registered in the Russian Valley, the entire area has been shown to be endemic for tick-borne encephalitis in spite of the low numbers of Ixodes persulcatus ticks due to the high rate of virus carrier infection (1.25 percent incidence of tick-borne encephalitis in I. persulcatus ticks in the central taiga subzone). The high incidence of infection among voles most likely stems from infection in the more southern areas that are endemic to the disease. Measures for preventing infection with tick-borne encephalitis include wearing protective clothing, examination by self and others for ticks, and gamma

globulin injections as soon as possible after tick bites. Figures 1; tables 1; references 8: Russian.

**Serologic Survey of Rural Population in Territory Endemic to Lyme Disease**

907C0854C Moscow MEDITSINSKAYA  
PARAZITOLOGIYA I PARAZITARNYYE BOLEZNI  
in Russian No 3, May-Jun 90 pp 15-16

[Article by E. I. Korenberg, M. I. Kalinin, I. A. Skripnikova, and L. M. Soldatkina, Scientific Research Institute of Evolutionary Morphology imeni N. F. Gamaleya, USSR Academy of Medical Sciences; Scientific Research Institute of Rheumatology, USSR Academy of Medical Sciences, Moscow; Kirov Rayon Sanitary and Epidemiologic Station, Leningrad Oblast]

UDC 616.98:579.843.114]-036.2-078.333

[Abstract] A serologic survey for antibodies to Lyme disease was conducted in November 1987 among 736 inhabitants of two rural communities (51 percent of the population) in the Kirov Rayon that have been shown to have the highest incidence of Lyme disease in the Leningrad Oblast. Survey results indicated that 53 - 60 percent of older people and 77 - 87 percent of those under 20 years of age had been in the forest, where Lyme disease is most often contracted, during the previous spring-summer period, with 12 percent reporting that they had found ticks on their persons that same year. About 9 percent of the population screened was shown to have antibodies to Lyme disease. Figures 1; tables 1; references 17: 9 Russian, 8 Western.

**First Cases of Lyme Disease in Lithuania**

907C0854D Moscow MEDITSINSKAYA  
PARAZITOLOGIYA I PARAZITARNYYE BOLEZNI  
in Russian No 3, May-Jun 90 pp 57-58

[Article by Z. I. Sasnauskene, Infection Department, Sixth Municipal Polyclinic, Vilnius]

UDC 616.98:579.834.114]-036.21(474.5)

[Abstract] Cursory description is presented of three fresh cases of Lyme disease diagnosed in Lithuania in 1987, where this disease was previously unknown. All of the cases were confirmed by indirect immunofluorescence and subsequently treated with penicillin and cured. Physicians report a need to familiarize the public with tick bite prevention and to familiarize doctors with the early clinical signs of Lyme disease and treatment procedures in order to preclude the serious complications inherent to this pathology. References 7: Russian.

**First Cases of Human Cryptosporidiosis in Moscow**

907C0854E Moscow MEDITSINSKAYA  
PARAZITOLOGIYA I PARAZITARNYYE BOLEZNI  
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[Article by A. V. Plotnikov, A. I. Andreyev, and A. Ya. Lysenko, Central Order of Lenin Advanced Physicians Training Institute, Moscow]

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[Abstract] Cryptosporidiosis, a zoonosis caused by the parasitic coccidia *Cryptosporidium* that afflicts the gastrointestinal tract, was purely a veterinary disease prior to 1976. Recently, it has been shown to be a frequent cause of self-limiting diarrhea in immunocompetent people, and chronic diarrhea in immunocompromised people, especially AIDS patients. A Finnish study showed that people who had been in Leningrad were five times more likely to be diagnosed with cryptosporidiosis than those who had visited other cities of the world. A 1989 study in Moscow conducted on 438 children aged 1 month to 10 years with acute intestinal disorders found *Cryptosporidium* oocytes in 3.65 percent (16) of feces samples. Also included are cursory clinical descriptions of two cases. These results demonstrate the need to draw the attention of infection specialists, parasitologists, and epidemiologists to the cryptosporidiosis problem in the USSR. References 17: 12 Russian, 5 Western.

**Around the Semipalatinsk Proving Ground: The Radioecological Situation, Radiation Exposures of the Population in Semipalatinsk Oblast (Based on Data from the Report of the International Commission)**

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pp 3-11

[Article by A. F. Tsyb, V. F. Stepanenko, V. A. Pitkevich, E. A. Ispenkov, A. V. Sevankaev (Scientific Research Institute of Medical Radiology, USSR Academy of Medical Sciences, Obninsk), M. Yu. Orlov ("Tayfun" Scientific Production Association, State Committee for Hydrometeorology and Environmental Protection of the USSR, Obninsk), E. V. Dmitriev (Institute of Applied Geophysics, State Committee for Hydrometeorology and Environmental Protection of the USSR, Moscow, I. A. Sarapultsev, T. L. Zhigareva (All-Union Scientific Research Institute of Agricultural Radiology, Obninsk), O. N. Prokofev, O. L. Obukhova (Central Scientific Research Institute of Roentgenology and Radiology, Ministry of Health of the Russian Socialist Federated Soviet Republics, Leningrad), L. F. Belovodskiy (Ministry of Atomic Energy and Industry of the USSR), V. M. Karimov, V. A. Rezontov, A. M. Matushenko, A. E. Katkov, V. N. Vyalykh, S. G. Smagulov, N. A. Meshkov, A.A. Saleev, S. E. Vildanov (Experts of the Ministry of Defense)]

UDC 614.73+614.875] (574.41)

[Text] Atomic weapons testing has been carried on for 40 years at the atomic proving grounds located 150 km from Semipalatinsk. The beginning of these tests was marked by the first underground explosion in the USSR of a nuclear charge on August 29, 1949. A number of other tests then followed, including the testing of a hydrogen bomb in the atmosphere in 1953. Since 1964 only underground tests have been carried out. According to available data, about 300 underground tests have been carried out from 1964 through July 8, 1989 [5, 7, 9].

The existence of the proving grounds and its activity has, for the inhabitants of Semipalatinsk Oblast, been a subject closed to public discussion. Complex, long-unresolved problems have gradually accumulated, most of which has been the improvement of the health of the ecological situation in the oblast, the reduction of the seismic activity of the explosions, the precluding of cases of the passage of radioactive substances beyond the boundaries of the proving grounds, the medical rehabilitation and compensation of the radiation effect on people in the period of the ground and atmospheric tests, and the improvement of the logistic support and cadre supply of practical public health in the oblast.

The lack of openness regarding the results of area and population radiation monitoring, the existing rigid conditions of secrecy, the inadequate level of knowledge regarding the influence of radiation on human health, and the effect of the seismic factor have all sustained and intensified the situation of mental and emotional stress among the residents of the oblast. The morbidity of children and cases of the occurrence of general and oncological diseases in adults have been regarded only as the result of the radiation effect.

The social-psychological situation reached a state of particular tension following the spread of inert radioactive gases beyond the boundaries of the proving grounds and their passage across population centers which occurred following the underground nuclear test of February 12, 1989.

In connection with the above, the Ministry of Health of the USSR, under the direction of the Deputy President of the Council of Ministers of the USSR, formed and sent to Semipalatinsk Oblast in May, 1989, an interdepartmental commission made up of leading specialists of the national and republic ministries of health, institutions of the Academies of Sciences and Medical Sciences of the USSR, the State Committee for Hydrometeorology and Environmental Protection of the USSR, the State Committee for Environmental Protection of the USSR, the State Committee for Agricultural Industry of the USSR, etc. The commission recruited representatives of the practical public health organs of the oblast and the republic, scientists of the Semipalatinsk Medical Institute, the Institute of Nuclear Physics of the Academy of Sciences of the Kazakh SSR, a number of scientific research organizations of the Ministry of

Health of the Kazakh SSR, broad strata of society, including the "Nevada-Semipalatinsk" movement.

### Study Methods

Twenty-two functional groups of experts in all were formed to study the ecological, radiological, and medical questions. Radiometry and radioactive monitoring groups studied the radioecological questions; the radiation exposures of the population were evaluated by specialists in medical and biological physics and radiation hygiene; and the role of nonradiation factors of the environment was also determined. An evaluation of possible long-term consequences of the radiation effect was also carried out.

Parameters of the ecological situation, especially of the radiation situation, were studied through direct on-site measurements, carried out conjointly with radiologist specialists and physicists of Kazakhstan in the presence of the public, and on the basis of an independent analysis of samples of soil, water, air, vegetation, food products, etc., performed in laboratories of Moscow, Obninsk, and Alma-Ata. Soviet-made modern field radiation monitoring and radiometric instruments (DRG-01-T, MKS-01-R-1), which permit the determination not only of the  $\gamma$ -exposure rate, but of the  $\beta$ - and  $\alpha$ -particle fluence rate from the objects examined, were utilized in carrying out the out-site measurements; foreign instruments for similar purposes were also used (Finland, Japan).

Laboratory investigations included, along with the gamma-spectrometry of samples, their radiochemical analysis with subsequent beta- and alpha-spectrometry. A careful intercalibration of all the apparatus utilized was performed before the carrying out of the measurements. Conjoint official protocols were drawn up on the basis of the results of the measurements.

The archival material of the proving ground regarding the radiation situation, and reports of special commissions examining the population and studying the radiological situation, were placed at the disposal of the commission. The radiation burdens of the population in the period in which the ground and atmospheric tests were carried out, starting with the first test of a nuclear charge in 1949, were assessed on this basis, as well as with the utilization of the results of measurements of the content of long-lived radionuclides by the commission.

The data obtained in the most careful manner were analyzed and formulated in the form of a detailed report, which was presented for open discussion at a scientific and practical conference, held July 17-19, 1989, at Semipalatinsk. Broad circles of society participated in the work of the conference. The materials of the commission were transmitted to correspondents of a number of central newspapers, and were sent to practical public health organs, to the Public Health Commission of the USSR Supreme Soviet, addressed to the appropriate departments. The conference approved the commission's conclusion.

Detailed materials, initial data, signed and certified results and measurement protocols, and calculations and assessments of a radiation monitoring and radiological character were presented in the appropriate divisions of the commission's report. A large collective of specialists and representatives of society, in addition to the authors of the article, took part in this effort as well as in the on-site measurements: R. A. Aytmagambetov, Chief Radiologist of the Ministry of Health of the Kazakh SSR; G. A. Batyrbekov, Deputy Director of the Institute of Nuclear Physics of the Academy of Sciences of the Kazakh SSR; E. S. Bekmukhambetov, I. V. Kazachevskiy, E. I. Zhukov, V. V. Voronin, specialists of this Institute; S. L. Turapin, specialist of the Institute of Oncology and Radiology of the Ministry of Health of the Kazakh SSR; B. S. Chegedekov and M. Kh. Kagan, representatives of the Sanitary-Epidemiological Station of Semipalatinsk and Semipalatinsk Oblast; V. G. Korbin, specialist of the Semipalatinsk division of the Soviet Committee for the Defense of Peace; V. P. Krylov, representative of the Chagan urban settlement; Yu. S. Kalinin, worker of the Sanitary-Epidemiological Station of Pavlodar Oblast; M. Kh. Eleusizov, Deputy Director of the Kazakh Planning and Survey and Scientific Research Institute for Water Utility Construction, representative of the "Nevada-Semipalatinsk" society; V. I. Deriglazov, responsible representative of the Ministry of Health of the USSR; and K. S. Belyaninov, correspondent of "Komsomolskaya Pravda".

Study results

*Population radiation doses for the period of ground and atmospheric tests.* It was established that two periods could be distinguished in the activity of the proving grounds over the course of forty years, significantly differing in the magnitude of the radiation effect on the population of the adjacent territories: the period of ground and atmospheric tests (1948-1963) and the period of underground tests (1964 through the present). The collective radiation doses (Table 1) which determine the possible remote consequences were formed in the period from 1949 (the first testing of a nuclear charge) through 1953 (the first testing of a hydrogen bomb). At the same time, the greatest radiation effect due to external and internal radiation is accounted for by the residence of a number of populations centers adjacent to the proving ground, of the Abayskiy, Beskaragayskiy, and the Zhanasemeyskiy rayons of Semipalatinsk Oblast: the towns of Dolon, Kaynar, Sarzhal, Karaul, and Semenovka (see Table 1; Tables 2 and 3). The main portion of the collective dose fell on individuals living in these towns in the period of the principal radiational effect. Taking into account the dispersed population and a number of other remote population centers, about 10,000 individuals in all were subjected to a heightened radiation effect during the period of atmospheric and ground tests.

**Table 1. Collective Doses of External Gamma Irradiation Resulting from the Consequences of Nuclear Tests by Five-Year Periods Following the Beginning of Ground and Atmospheric Tests, for the Inhabitants of a Number of Population Centers of the Abayskiy, Beskaragayskiy, Zhanasemeyskiy Rayons and Semipalatinsk**

Rayon, populated center	Collective Doses, man.Sv			
	1949-1953	1954-1958	1958-1963	Total across years
Abayskiy	602	0.18	Q	602.2
Beskaragayskiy	1330	11	56	1397
Zhanasemeyskiy	0.1	6	Q	6.1
Semipalatinsk	Q	607	Q	607
Total	1932.1	624.2	56	2612.3

**Table 2. Collective Doses of External and Internal Irradiation of the Thyroid Gland and the Hematopoietic Bone Marrow, Resulting from the Consequences of Nuclear Tests by Five-Year Periods Following the Beginning of Ground and Atmospheric Tests, for the Inhabitants of Semipalatinsk Oblast and Semipalatinsk (for Abaskiy and Beskaragayskiy Rayons the Doses Indicated are for the Period 1949-1953; for the Zhanasemeyskiy Rayon and Semipalatinsk the Doses Indicated are for the Period 1954-1958)**

Rayon, populated center	Collective internal (numerator) and external (denominator) radiation doses, man.Sv	
	to the rayon of the thyroid gland (thyrocongenic)	to the hematopoietic bone marrow
Abayskiy	1896/602	1956/602
Beskaragayskiy	2164/1330	54/1330
Zhanasemeyskiy	60/6.1	Q/6.1
Semipalatinsk	6100/607	Q/607

**Table 3. Average Effective Dose Equivalents, Resulting from the Consequences of Nuclear Tests by Five-Year Periods Following the Beginning of Ground and Atmospheric Tests, for the Inhabitants of a Number of Population Centers of Semipalatinsk Oblast (Taking into Account External Irradiation and All Available Information on Internal Irradiation)**

Populated center	Effective dose equivalents, Gy
t. Dolon	1.6 (result of 1949 explosion)
t. Abay (Karaul)	0.37
t. Kaynar	0.24
t. Sarzhal	0.20
t. Semenovka	0.02
Semipalatinsk*	0.0056

\*There are also a number of other populated centers for which the annual radiation burdens of the population can range from 0.005 to 0.02 Gy. The contribution of these populated centers to the total collective dose is taken into account

It should be noted that the calculation of doses from external radiation was carried out by the commission on the basis of the maximum permissible limit. The contribution of internal radiation was assessed on the basis of the radionuclides of iodine and strontium. Possible doses from the radioactive isotopes of plutonium are not included in the radiation doses of the 1949-1953 period. This is associated with the fact that analysis of the soil samples selected by the commission for the content of plutonium is not yet complete. The data on the internal radiation are based on the preserved archival materials, and may be refined in the future. The implementation of a special investigatory program for the mathematical modeling of nuclear test explosions, taking account of the real characteristics of the charges and the weather conditions, seems advisable for this purpose.

*Possible remote consequences of the radiation effect.* The commission did not have the information at its disposal indicating cases of acute radiation illness in the population during the period of the ground and atmospheric tests. At the present time, with the passage of 26 - 40 years, it is necessary to consider the possibility of remote consequences of a probabilistic nature, namely, oncological diseases and genetic defects. Proceeding from the estimated values of the collective doses, and using the coefficients of risk recommended by the UNSCEAR [United Nations Scientific Committee on the Effects of Atomic Radiation] [8], it is possible to estimate the expected number of cases of oncological diseases caused by the radiation effect, as compared with their natural incidence. In absolute numbers (for the above-indicated group of 10,000 individuals), the contribution of the radiation factor in the additional oncological morbidity, based on a prognostic calculation for the 40-year period from the beginning of the tests, could amount to 55 additional cases of tumors beyond the spontaneous level of 824 cases. From the number of additional tumors indicated, the predicted number of myeloid leukemias is 5 cases, and the number of tumors of the thyroid gland, 6 cases. These data are similar to the predicted estimates for other situations in a similar range of collective doses. For Semipalatinsk, the possible increase in oncological diseases due to the radiation factor from the ground tests and the atmospheric tests could amount to 16 cases over

a lifetime, for a spontaneous level of 10,350 tumors. At the same time, it must be emphasized that, with due account taken, of the indeterminacy in the values of the coefficients of radiation risk and the magnitudes of the absorbed doses, the above-cited prognostic estimate of the additional number of radiation-induced tumors may differ from the actual number by a factor of 3 - 5.

Unfortunately, the yearly statistical records of the actual dynamics of the prevalence of malignant tumors and mortality caused by them for the 40-year period were often kept by the public health organs only on the basis of clinical data (without autopsy), and therefore may contain substantial inaccuracies. The commission did not have reliable information at its disposal on oncological morbidity from the beginning of the 1950s. For this reason it was impossible to evaluate the actual frequency of the myeloid leukemias which are typical for the effect of radiation and which are manifested first in the earlier periods following irradiation (7 - 15 years), as compared with the solid tumors.

Cytogenetic investigations were carried out in 98 individuals from the risk group and the control group. The predominance of aberrations of the chromosomal type with the presence of complex structural rearrangements was found against the background of a general increase in their frequency in individuals from the group subjected to the radiation effect in the period of ground and atmospheric tests. This confirms the fact of the radiation effect on the organism of individuals from the risk group. However, the frequency of chromosomal aberrations was found to be elevated in subjects of the control rayon, in which the population was not subjected to the radiation effect, but in these individuals it is in line with chemical mutagens.

In the opinion of commission members, it is necessary in the future to study the population effects of the influence of all environmental mutagenic factors in greater depth and more extensively, as well as to determine the natural level of chromosomal aberrations characteristic for this period.

*Radiation doses for the period of the underground tests.* The period of the underground tests (1963-1989) differs

substantially with respect to the radiation effect from the ground and atmospheric tests. In assessing the possible irradiation of the population in this period, the entrance of long-lived radionuclides into the organism with the local diet, due to the presence of radioactive traces from the atmospheric and ground tests in the past, and cases of the escape of radioactive gases beyond the limits of the proving grounds during the testing of underground nuclear devices, were taken into account. Due to the absence of complete archival data for 1963 - 1969, the population radiation doses were established beginning in 1970. The calculations were made for the years which were most unfavorable from the radiation hygiene perspective.

Some increase in the yearly levels of external radiation in 1986 - 1987 above the average annual natural background level should be noted. In 1986 this could have been caused by radioactive fallout due to the accident at the Chernobyl atomic power station, which is confirmed by a ratio of the  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  radionuclides which were characteristic for the accident. In 1987 some excess was caused by the activity of the proving grounds. It was established that the dose absorbed beyond the natural background in that year for the urban population was equal to 0.0006 Gy, and 0.001 Gy for the rural population, which are 12 - 20 percent of the dose limit established for category B individuals [4]. In the following years, the additional doses from  $\gamma$ -radiation were approximately 10 times lower than in 1987. The annual doses were also substantially lower in the period up to 1987.

The annual doses of internal radiation were estimated for 1987 from all long-lived radionuclides in the environment, as well as for 1974, when the appearance of traces of  $^{131}\text{I}$  was recorded in the environment by the oblast veterinary laboratory. The equivalent dose of whole-body irradiation and irradiation of the critical organs due to all possible paths of entrance of radionuclides into the organism proved to be 10 times lower than the maximum annual radiation doses for the population of category B. The internal radiation dose of  $^{131}\text{I}$  of the thyroid gland of children was 30 percent in 1974 (criticality accident dosimeter with maximal doses). The equivalent dose to the skin from  $\beta$ -radiation due to the passage of radioactive inert gases is less than 14 percent of the maximum annual dose to the cutaneous integuments for the population.

The annual effective equivalent doses, which take the summary external and internal radiation in the period under review into account, were within the limits of millionths of a gray to 0.0016 Gy in 1987. This was about 0.0002 Gy per year on the average. Additional internal radiation at a level of about 0.0001 Gy per year should be added to this value for the residents of Semipalatinsk due to 1 curie of various natural radionuclides entering the atmosphere annually from the burning of Ekibastuz coals in boiler rooms and heat-and-electric-supply stations. The emission of inert gases which took place after the test of February 12, 1989 led to the additional

irradiation of residents of a number of population centers at a dose of 0.00001 - 0.00005 Gy.

Thus, the annual whole-body radiation doses in the last 19 years in the population centers rayons adjacent to the proving grounds and in Semipalatinsk was less than 0.005 Gy (the annual whole-body MD for category B). The annual radiation doses of individual organs and tissues were also lower than the annual radiation limits of these organs for a category B population.

*The radiation situation with respect to the May 1989 condition.* During the period of the operation of the commission, a detailed operational study of the radiation situation in Semipalatinsk and 26 population centers of the Abayskiy, Beskaragayskiy, and Zhanasemey-skiy rayons, as well as in the city of Kurchatov and the Chagan urban settlement was carried out. The measurements were carried out along previously selected automobile and helicopter routes. Information regarding possible traces of radioactive fallout during the period of ground and atmospheric tests, sent to the commission by representatives of the "Nevada" movement, were utilized in the process. In addition, the maps and other documents regarding the radiation situation beyond the boundaries of the proving grounds, starting in 1949, which were available at the proving grounds, were placed at the disposal of the commission.

Members of the commission, including the chief radiologist of the Ministry of Health of the Kazakh SSR and specialists of the Institute of Nuclear Physics of the Academy of Sciences of the Kazakh SSR, together with representatives of the "Nevada" movement, measured the exposure dose rate in the localities (the gamma background), as well as the levels of the beta-space and alpha-activity of the soil. In all cases, soil samples, and samples of vegetation, drinking and natural water, bio-samples of agricultural animals, of fish from natural bodies of water, and of milk from personal smallholdings, as well as air filters taken on the routes along the boundaries of the proving grounds were selected for subsequent spectroradiometric and radiochemical laboratory analysis. The results of the measurements were put in order using collaborative protocols, and selected specimens of the samples were divided and sent for independent analysis to the Institute of Nuclear Physics of the Academy of Sciences of the Kazakh SSR (Alma-Ata), to the "Tayfun" Scientific Production Association, State Committee for Hydrometeorology and Environmental Protection of the USSR, the All-Union Scientific Research Institute of Agricultural Radiology (Obninsk), as well as to the I. V. Kurchatov I. Institute of Atomic Energy (Moscow), and to the laboratories of the proving grounds. In addition, specialists of the commission were prepared to send the available samples for international expert appraisal, and to carry out repeat measurements on site as necessary with the participation of international experts.

Studies of the radiation situation in the Abayskiy, Beskaragayskiy, and Zhanasemeyskiy rayons, Semipalatinsk, the city of Kurchatov, and the Chagan urban settlement showed that the on-site gamma exposure dose rate were, as a rule, within the limits of the natural values, up to 20  $\mu\text{R}/\text{h}$  (Table 4). The average values of the gamma background for Semipalatinsk and the city of Kurchatov was 15  $\mu\text{R}/\text{h}$ , and for the Chagan urban settlement, 16  $\mu\text{R}/\text{h}$  with respect to the gamma background, two zones close to the boundary of the proving grounds were the exception (one of the two zones is located in the region of the issuing of the Ashysu River into the Shagan River, and the second, between the settlement of Bestamak and the town of Sarzhal), in which the on-site exposure dose rate reached 30  $\mu\text{R}/\text{h}$ , which was caused by traces of long-lived radionuclides, which had precipitated as the result of nuclear tests carried out in the 1960s. The increased level of the

$\beta$ -particle fluence rate from the soil (up to 23 particles per  $1\text{ cm}^2$  in 1 min) was observed in the Taylan winter station (see Table 4). This level exceeds the natural values for the local soils by a factor of 2 - 3. The upper limit of the values of the  $\alpha$ -particle fluence rate from the steppe soils reached 0.28  $\alpha$ -particles per  $1\text{ cm}^2$  in 1 min in several areas (see Table 4), which exceeds several-fold the measured values for the overwhelming number of areas in the other territories examined. In a number of population centers (the town of Dolon, the Taylan winter station, the Akbulak settlement, the town of Karaul, the Bestamak settlement, and the region west of the town of Sarzhal), a burial effect was observed: the level of the  $\alpha$ -particle fluence rate from the soil reached a maximum depth of about 10 cm, and subsequently decreased to a depth of 30 cm (see Table 4). This circumstance indicates that we are dealing with radioactive fallout from many years ago, which in the course of time has receded into the depths from the upper layers of the soil.

**Table 4. Average Exposure Dose in the Air ( $R_g$ ),  $\alpha$ -( $F_a$ ) and  $\beta$ -( $F_b$ ) Particle Fluence Rates from the Soil of Population Centers of a Number of Rayons of Semipalatinsk Oblast**

Population center	$R_g$ , R/h	$F_b$ , particles per $1\text{ cm}^2$ per min	$F_a$ , particles per $1\text{ cm}^2$ per min at different soil depths	
			0 cm	10 cm
t. Znamenka	13	3	0.28	0.27
set. Shcherbakovka	15	8	0.14	Q
set. Novopokrovka	13	2	0.10	0.17
t. Novaya Shulba	13	3	0.16	0.06
t. Zharma	17	7	0.27	0.10
Chagan urban settlement	16	Q	0.09	Q
set. Kyzylkain	14	3	0.05	Q
set. Mostik	12	3	Q	Q
t. Dolon	13	5	0.10	0.68
t. Bolshaya Vladimirovka	13	8	0.12	0.20
set. Kanonerka	13	6	Q	Q
Taylan winter station	14	23	0.07	0.20
t. Sarzhal	14	10	0.14	0.12
30 km from Sarzhal	15	4	0.05	0.38
Sarapan winter station	14	Q	0.07	0.05
0.5 km from Sarapan winter station	16	3	0.16	0.10
t. Kaynar	16	6	0.10	Q
set. Akbulak	13	7	0.27	0.67
set. Bestamak	12	6	0.19	0.36
t. Karaul	13	Q	0.19	0.27
set. Olzhabay	14	4	Q	Q
set. Zhurekadyr	12	3	Q	Q
Lake Barlykak	15	Q	0.25	0.21
Kurchatov	15	Q	Q	Q
Semipalatinsk	15	Q	0.07	Q

On the basis of the results of the measurements of the samples selected by the commission (the measurements were carried out by "Tayfun" Scientific Production Association, State Committee for Hydrometeorology and Environmental Protection of the USSR [7]), the level of the  $^{137}\text{Cs}$  in the soil did not exceed  $0.48 \text{ Ci/km}^2$  (the Taylan wintering station), and as a rule was equal to hundredths of a curie per  $1 \text{ km}^2$  (the minimum was  $0.02 \text{ Ci/km}^2$  in the Chagan urban settlement), which corresponds to the level of global fallout as the result of atmospheric testing carried out by the nuclear powers. The density of  $^{90}\text{Sr}$  pollution in the samples from the surface layer of the soil was within the limits of  $0.013 \text{ Ci/km}^2$  (the town of Znamenka) to  $0.05 \text{ Ci/km}^2$  (the Taylan wintering station). At a depth of 10 cm, the maximum soil contamination (the town of Dolon) was somewhat less than  $0.5 \text{ Ci/km}^2$  with respect to  $^{137}\text{Cs}$  and  $0.15 \text{ Ci/km}^2$  with respect to  $^{90}\text{Sr}$  (Table 5).

**Table 5. Content of Radionuclides in Virgin Steppe Soil Samples on the Territory of the Town of Dolon**

Soil depth, cm	Activity of radionuclides, Ci/kg		
	$^{137}\text{Cs}$	$^{90}\text{Sr}$	$^{239}\text{Pu}, ^{240}\text{Pu}$
0-5*	$6.0 \cdot 10^{-10}$	$4.1 \cdot 10^{-10}$	$2.0 \cdot 10^{-10}$
5-10	$2.0 \cdot 10^{-9}$	$5.7 \cdot 10^{-10}$	$8.0 \cdot 10^{-10}$
10-15	$1.9 \cdot 10^{-9}$	$5.4 \cdot 10^{-10}$	$4.6 \cdot 10^{-9}$
15-20	$2.5 \cdot 10^{-10}$	$2.5 \cdot 10^{-10}$	$1.5 \cdot 10^{-10}$
20-30	$0.5 \cdot 10^{-10}$	Q	$2.0 \cdot 10^{-10}$

\*On the basis of the surface density of contamination of the soil for a layer at a depth to 5 cm, the  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  contamination is  $0.01 \text{ Ci/kg}$

Radiochemical analysis with follow-up alpha-spectrometry [7] showed that the density of contamination of the upper layer of the soil (down to the 5 cm) in the region of the town of Dolon was equal to  $0.01 - 0.02 \text{ Ci/km}^2$  with respect to  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$ . At a depth of 10 - 15 cm, the soil contamination with radionuclides of plutonium, in the region of the town of Dolon, was  $0.2 - 0.3 \text{ Ci/km}^2$ , which attests to a remote (1949) radioactive contamination of the locality (see Table 5). Here the plutonium is found in the fixed form. Trace concentrations of other long-lived radionuclides ( $^{152}\text{Eu}$ ,  $^{154}\text{Eu}$ , and  $^{60}\text{Co}$ ) were also found in soil, which is a consequence of the ground and atmospheric nuclear tests from 1949 - 1963.

Analysis of samples of the meat and bones of farm animals, milk, and drinking and natural water for the level of gamma- and beta-activity showed that the concentration of radioactive substances in them was 10, 100, and more times lower than the maximum allowable levels according to Radiation Protection Standard-68/87 [4]. This indicates that in the years which have passed since the atmospheric and ground tests, the radionuclides which have fallen onto the soil have changed to a poorly-mobile form, and in small amounts.

Analysis of the air filters [6] showed that the concentrations of gamma- and beta-emitting radionuclides in the air was 100 - 1,000 times lower than the allowable limits according to Radiation Protection Standard-76/87, and were mainly caused by radioactive precipitation which fell in 1986 following the accident at the Chernobyl atomic power station, which is indicated by a ratio between the activity of  $^{134}\text{Cs}$  and  $^{137}\text{Cs}$  which is characteristic for this accident.

The radiochemical analysis for the plutonium content of the air filters sampled on the routes along with the boundaries of the proving grounds was performed independently in the laboratories of the "Tayfun" Scientific Production Association, State Committee for Hydrometeorology and Environmental Protection of the USSR (Obninsk) and the I. V. Kurchatov I. Institute of Atomic Energy (Moscow) [7]. It was established that the concentrations of  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  in the air was 3 - 15 times lower than the allowable levels according to Radiation Protection Standard-76/87 for the routes encompassing the territory of the proving grounds from the north, southeast, and south. Analysis of the soil samples taken from the same routes showed that the surface density of contamination with  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  was within the limits of  $0.01 - 0.05 \text{ Ci/km}^2$ .

Short-lived radionuclides as well as radionuclides with a medium life-span were not found in all of the samples. This attests to the absence of contamination of the environment and food products as the result of the underground of nuclear tests. Short-lived radionuclides were also absent in samples from the region of the Chagan urban settlement, in which an increase in the  $\gamma$ -radiation background following the test explosion of February 12, 1989 was observed. Thus, it was confirmed that the plume of inert radioactive gases which formed after this explosion and which passed across the settlement, admixtures of other radioactive substances were absent.

Soil samples were also selected in the immediate region of the epicenter of the underground test nuclear explosion carried out July 8, 1989. In these samples as well, taken for 30 min, 2 days after the explosion to the windward sides of the epicenter; it was not possible to find short-lived radionuclides, and the concentration of  $^{137}\text{Cs}$  in them did not differ from the concentrations in the remaining centers of the territory examined. This implies that the test of July 8, 1989 did not lead to the egress to the surface of the soil of radionuclide fission products.

The satisfactory coincidence overall of the results of the independent measurements of all the samples, carried out by specialists of the Institute of Nuclear Physics, Academy of Sciences of the Kazakh SSR and specialists of the proving grounds, and in the laboratories of the "Tayfun" Scientific Production Association, State Committee for Hydrometeorology and Environmental Protection of the USSR, should be noted. The results of the determination by various laboratories of contamination



of the surface layer of the soil with  $^{137}\text{Cs}$  at various population centers are presented in comparative terms as an example in Table 6. The samples were selected from areas of soil located near each other. The data obtained by specialists of the Academy of Sciences of the

Kazakh SSR on the soil contamination are, as a rule, somewhat understated by comparison with analogous data obtained in the laboratories at Obninsk and the proving grounds.

**Table 6. Results of the Determination of the  $^{137}\text{Cs}$  Content by Various Laboratories in Soil Samples Taken from Closely Located Areas of Virgin Steppe Soil**

Population center	Density of the $^{137}\text{Cs}$ contamination of the surface layer of the soil (0-5 cm), Ci/kg		
	"Tayfun" SPA	test range	Institute of Nuclear Physics, AS KSSR
set. Kyzylkain	0.181	0.030	0.061
set. Mostik	0.053	0.080	0.032
t. Dolon	0.118	0.080	0.078
t. Malaya and Bolshaya Vladimirovka	0.045	0.090	0.031
Taylan winter station	0.476	Q	0.320
t. Kaynar	0.112	0.100	0.032
set. Akbulak	0.180	0.090	0.037
t. Sarzhal	0.172	Q	0.090
set. Bestamak	0.067	0.060	0.040
t. Znamenka	0.055	0.060	0.032
set. Shcherbakovka	0.102	0.090	0.024
set. Kanonerka	0.115	0.070	0.100
t. Karaul	0.161	0.100	0.087
set. Zhurekadyr	0.048	0.040	0.066
set. Novopokrovka	0.022	0.070	0.043
t. Novaya Shulba	0.052	0.070	0.030
t. Zharma	0.113	0.090	0.025
Lake Barlykak	0.071	0.100	0.056

As we know, the Radiation Protection Standard-76/87 did not provide for norming with respect to the criterion of soil contamination, since such norming is carried out either on the basis of the population radiation doses, or on the basis of the degree of contamination of food products, water, and air. At the same time, it may make sense to compare the data presented in Table 6 on the degree of soil contamination in Semipalatinsk Oblast with analogous information for the territories on which the fallout of radioactive deposits took place as a result of the accident at the Chernobyl atomic power station, since the level of soil contamination has been accepted for these territories as a rough criterion for the carrying out of appropriate measures.

Comparison of this sort has shown [1-3] that after the accident at the Chernobyl atomic power station,  $^{137}\text{Cs}$  contamination greater than  $15 \text{ Ci/km}^2$  took place in a number of regions of the Belorussian SSR, the Ukrainian SSR, and the RSFSR, which exceeds the data presented in Table 6 by a factor greater than 30. Constant radiological monitoring and the carrying out of measures which exclude the exceeding of levels of irradiation of the population beyond the established norms (including

resettlement) are obligatory for such territories. Soil contamination ranges from single units up to  $15 \text{ Ci/km}^2$  in more extensive territories, i. e., from several times up to tens of times greater than the contamination levels presented in Table 6. At this time a regime of radiological observation has been established, measures for the reduction of the entrance of radioactive substances into food products have been recommended and are being carried out, and in cases in which exceeding the established levels for the irradiation of the population cannot be eliminated, the resettlement of the population is provided for. Practice has shown that with  $^{137}\text{Cs}$  soil contamination less than  $1 \text{ Ci/km}^2$ , the exceeding of the levels for the irradiation of the population beyond  $0.005 \text{ Gy}$  in a year (in accordance with Radiation Protection Standard-76/87) is not observed, which is in accordance with data obtained by the commission for Semipalatinsk Oblast.

Members of the commission directed the attention of responsible directors of the proving grounds and of the oblast to the impermissibility of cases where there is a violation of the rules of radiation protection for the population. The proving grounds as a whole do not have

fencing, although it is a protected and controlled zone. In the overwhelming proportion of its territory by area a normal radiation situation is present, at the level of natural background values. Only individual localized areas of the proving grounds, on which ground tests were carried out in the past, constitute the exception. The leaders of the rayons and of farms located alongside the proving grounds annually present themselves with requests for the provision of proving grounds territory for the procurement of feeds and the grazing of cattle. Such a possibility has been submitted with the indication of forbidden zones, in which the presence of people and cattle is impermissible. However, these prohibitions are frequently violated, which may lead to the appearance of radioactivity in food products, namely, whole milk and meat. The commission demanded the undertaking of all necessary measures for the exclusion of cases of the utilization of contaminated areas of the proving grounds for agricultural, industrial, and other types of activity on the part of the population.

The recommendations of the commission:

1) the population that is living on territories adjacent to the proving grounds, which received increased doses of radiation in the period 1949-1963, should be assigned to the elevated risk group;

2) it is advisable for the Semipalatinsk Oblast Executive Committee of the Soviet of People's Deputies to go with a petition to the Counsel of Ministers of the USSR regarding consideration of questions of imposing order on the remuneration of labor, determining the benefits and compensations to be made to residents of the population centers which were subjected to increased radiation effect in this period, regarding additional financing for the improvement of the medical service and living conditions \*\*\*\*\*, and regarding the improvement of the quality and structure of the diet of children. Assistance is required in the supply of the treatment and preventive institutions of the regions adjacent to the proving grounds by providing them with modern medical equipment and drugs;

3) before the question of the further activity of the proving grounds is decided, it is advisable to assure measures for decreasing the possibility of the emission of radioactive inert gases and for limiting the seismic effects, by cutting down the number of tests to be conducted, with a simultaneous decrease in the force of the explosions and the use of technology which prevents the worsening of the radiation situation beyond the boundaries of the proving grounds.

4) it is necessary to implement a complex of measures to assure the participation of organs of the local authorities, the oblast sanitary-epidemiological station and the oblast veterinary laboratory, and the oblast Committee on Environmental Protection, in the monitoring of the observance of radiation protection requirements in the rayons adjacent to the proving grounds, and to take measures to exclude cases where there is utilization of

the contaminated areas of the proving grounds for agricultural, industrial, and other types of activities of the population;

5) to go with a petition to the appropriate levels of authority with regard to the creation of a republic Scientific Research Institute of Radiation Medicine and Hygiene in Alma-Ata, with a branch at the Semipalatinsk Medical Institute;

6) the implementation of a special scientific program which permits the mathematical modeling of the test explosions which took place in the 1949-1963 period, taking the actual characteristics of the charges and weather conditions into account, is advisable in order to define more precisely the population radiation doses in the period of ground tests and atmospheric tests. Carrying out more detailed radioecological investigations is advisable with the same purpose in mind; in particular, analysis of bone, ceramic, and crystal samples, witnesses of the period of the ground and atmospheric tests, for the content of radiation-induced free radicals using ESR methods and luminescent spectrometry, would seem of great interest. Study of the content of long-lived  $^{129}\text{I}$  in the region may prove to be highly informative;

7) implementation of a scientific-practical program of retrospective assessment of the dynamics of oncological morbidity in the rayons of Semipalatinsk Oblast for 40 years is required;

8) it is necessary to remove the seal of secrecy from all materials regarding the radiation situation beyond the boundaries of the proving grounds, beginning with the first nuclear explosion in 1949. It is necessary to publish a map of all radioactive traces which have formed beyond the limits of the proving grounds, with indication of the date of their occurrence and the principal parameters of the radiation situation.

#### Conclusions

1. Two periods, which differ significantly with respect to the magnitude of the radiation effect on the population of the adjacent territories can be distinguished in the activity of the proving grounds over a period of 40 years: (\*\*\*\*\* 1963) and underground tests (from 1964 through the present).

The collective radiation doses which determine possible remote consequences were formed mainly in the period from 1949 (the first test of a nuclear charge) through 1953 (the first test of a hydrogen bomb). At the same time, the greatest radiation effect due to external and internal irradiation is accounted for by the residence of a number of population centers, adjacent to the proving grounds, of the Abayskiy, Beskaragayskiy, and Zhanasemeyskiy rayons of Semipalatinsk Oblast: the town of Dolon, 1.6 Gy; the town of Abay (Karaul), 0.37 Gy; the town of Kaynar, 0.24 Gy; the town of Sarzhal, 0.20 Gy; and the town of Semenovka, 0.02 Gy. There are also a number of other population centers for which the annual population radiation doses could have been 0.005 - 0.02

Gy. In all, about 10,000 residents were subjected to an increased radiation effect in the period of atmospheric and ground tests. The greatest radiation dose of the population of Semipalatinsk in the period of the ground tests and the atmospheric tests was 0.0056 Gy.

2. In absolute numbers, the contribution of the radiation factor to additional oncological morbidity for the risk group per 10,000 individuals, based on the predictive calculation for the 40 year period could be 55 additional cases of tumors beyond the spontaneous level of 824 cases. For Semipalatinsk, the possible increment in oncological diseases due to the radiation factor from the ground tests and the atmospheric tests could be 16 cases over the lifetime, with a spontaneous level of 10,350 tumors.

Taking the indeterminancies in the values of the radiation risk coefficients and the magnitudes of absorbed doses into account, the estimate of the additional number of radiation-induced tumors may differ from the actual number by a factor of 3 - 5.

3. The greatest annual external radiation doses of the population during the period of the underground tests took place in 1987. They were 12 percent (the urban population) and 20 percent (the rural population), respectively, of the dose limit established for category B individuals (0.005 Gy). In the same year, the equivalent internal radiation dose from all long-lived radionuclides was found to be more than ten times lower than the maximal annual radiation dose for the category B population. The equivalent dose to the skin from  $\beta$ -radiation due to cases of the efflux of radioactive nerve gases did not exceed 14 percent of the annual dose limit to the cutaneous integuments for the population. The highest level of internal irradiation by  $^{131}\text{I}$  of the thyroid gland of children (criticality accident dosimeter with maximal doses) took place in 1974 and constituted 30 percent of the annual dose limit for category B. The annual effective equivalent dose, which takes into account total external and internal radiation, was 0.0016 Gy in 1987 (the highest value). The escape of inert gases which took place after the test of February 12, 1989, led to the additional irradiation of the residents of a number of population centers to a dose of 0.00001 - 0.00005 Gy. Thus, the annual whole-body radiation doses, as well as annual radiation doses of individual organs and tissues, was lower in recent years than the annual radiation limits for a category B population in the population centers, adjacent to the proving grounds, of the rayons and in Semipalatinsk.

4. In May, 1989 (the period of the work of the commission), the radiation situation in the territories adjacent to the Semipalatinsk proving grounds was characterized by the following parameters. The exposure dose rate in the air in 22 population centers examined, including the city of Kurchatov, Semipalatinsk, and the Chagan urban settlement, corresponded to the natural values, and did not exceed 17  $\mu\text{R}/\text{h}$ . Two zones close to the boundary of the proving grounds (in the region of the issuing of the

Ashysu River into the Shagan River, and between the settlements of Bestamak and Sarzhal), where the exposure dose rate on-site reached 30  $\mu\text{R}/\text{h}$ , which was caused by traces of long-lived radionuclides which had fallen out as the result of nuclear tests carried out in the 1960s, were the exception.

5. The results of the measurements of the samples show that the level of the contamination of soils with  $^{137}\text{Cs}$  does not exceed 0.48  $\text{Ci}/\text{km}^2$  (Taylan wintering station), and as a rule, is at the level of hundredths of a curie per 1  $\text{km}^2$  (minimum, 0.02  $\text{Ci}/\text{km}^2$  at the Chagan urban settlement), which corresponds to the ubiquitous level of global fallout as a result of the atmospheric tests carried out by the nuclear powers. The density of contamination with  $^{90}\text{Sr}$  in the samples of the surface layer of the soil ranges from 0.013  $\text{Ci}/\text{km}^2$  (the Znamenka settlement) to 0.05  $\text{Ci}/\text{km}^2$  (Taylan wintering station). Contamination of the surface layer of the soil with the radionuclides  $^{239}\text{Pu}$  and  $^{240}\text{Pu}$  was equal to 0.01 - 0.02  $\text{Ci}/\text{km}^2$ . The contamination of the soil with radionuclides with plutonium was 0.2 - 0.3  $\text{Ci}/\text{km}^2$  at a depth of 10 - 15 cm in the region of the town of Dolon, which indicates remote radioactive fallout at that site. In this case the plutonium is found in a fixed form. Trace concentrations of other radionuclides ( $^{152}\text{Eu}$  and  $^{154}\text{Eu}$ ,  $^{60}\text{Co}$ ) were also found, which is the result of nuclear ground and atmospheric tests in 1949-1963.

#### Footnotes

1. Data on the Radioactive Contamination of Population Centers of the Belorussian SSR with Cesium-137 and Strontium-90 (in June 1989). Moscow, 1989.
2. Data on the Radioactive Contamination of Population Centers of the Ukrainian SSR with Cesium-137 and Strontium-90 (in June 1989). Moscow, 1989.
3. Data on the Radioactive Contamination of Population Centers of the RSFSR with Cesium-137 and Strontium-90 (in June 1989). Moscow, 1989.
4. Radiation Protection Standards, RPS-76/87, and the Principal Sanitary Regulations for Work with Radioactive Substances and Other Sources of Ionizing Radiation, PSR-72/87, Third Ed., Moscow, 1988.
5. Irradiation as the Result of Tests of Nuclear Arms and the Nuclear Fuel Cycle for Military Purposes (Thirty-fourth Session of the UNSCEAR [United Nations Scientific Committee on the Effects of Atomic Radiation]), Vienna, 1985.
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9. J. Lander and R. Arasrog, Nuclear Explosions 1945-1972: Basic Data, Stockholm, 1973.

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**The Medical Sequelae of the Radiation Accident in the Southern Urals in 1957**

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[Article by L. A. Buldakov, S. N. Demin, M. M. Kosenko, V. A. Kostyuchenko, N. A. Korshunikova, L. Yu. Krestinina, M. M. Saurov, I. A. Ternovskiy, Z. B. Tokarskaya, V. L. Shvedov (Moscow)]

[Text] On September 29, 1957, an outbreak of waste products, leading to the discharge of radioactive products of fission into the atmosphere and to their subsequent dispersion and precipitation on part of the territory of Chelyabinsk, Tyumen, and Sverdlovsk Oblasts took place as the result of egress of nitrate-acetate hot wastes from the line of the cooling system of the concrete tank. About  $210^6$  Ci ( $7.410^{16}$  Bq) were discharged [3, 4]; the composition of the mixture is presented in Table 1.

**Table 1. Characteristics of the Mixture of Radionuclides of the Accidental Discharge**

Radionuclides	Contribution to the activity of the mixture, %	Half-life	Type of radiation	Nature of radiologic danger
$^{89}\text{Sr}$	Traces	51 days	$\beta$	Internal irradiation (skeleton)
$^{90}\text{Sr}+^{90}\text{Y}$	5.4	28.6 y	$\beta$	Internal irradiation (skeleton)
$^{95}\text{Zr}+^{95}\text{Nb}$	24.9	65 days	$\beta, \gamma$	External irradiation
$^{106}\text{Ru}+^{106}\text{Rh}$	3.7	1 y	$\beta, \gamma$	the same
$^{137}\text{Cs}$	0.036	30 y	$\beta, \gamma$	External and internal irradiation
$^{144}\text{Ce}+^{144}\text{Pr}$	66	284 days	$\beta, \gamma$	External irradiation
$^{147}\text{Pm}$	Traces	2.6 y	$\beta$	Internal irradiation
$^{155}\text{Eu}$	Traces	5 y	$\beta$	the same
$^{239}\text{Pu}$	Traces	Q	$\alpha$	the same

Within the limits of a contamination density of 0.1 Ci/km<sup>2</sup> with respect to  $^{90}\text{Sr}$  (twice the level of global radioactive contamination), the maximum length of the radioactive track formed reached 300 km; within the

limits of 2 Ci/km<sup>2</sup> with respect to  $^{90}\text{Sr}$ , 105 km, with a width of the track of 8 - 9 km [2, 3]. The distribution of area with respect to the density of radioactive contamination is presented in Table 2.

**Table 2. Area and Size of Population on Territory Subjected to Contamination**

Density of radioactive contamination based on $^{90}\text{Sr}$ Ci/km <sup>2</sup>	Area of Territory, km <sup>2</sup>	Size of population, in thous.
0.1	15,000	270
Including:		
>2	1,000	10.73*
100	120	9.58*
1000	20	1.150*

\*Population evacuated.

The presence in the mixture of  $\gamma$ -emitting nuclides caused the external irradiation of the population and natural objects. In the initial period, the dose rate was about 150 SR/h per 1 Ci/km<sup>2</sup> with respect to  $^{90}\text{Sr}$ , with maximum values of about 0.6 R/h at the head end of the track, where the density of contamination reached 4,000 Ci/km<sup>2</sup> with respect to  $^{90}\text{Sr}$ .

As a result of the radioactive decay of the short-lived nuclides, the levels of radioactive contamination of the territory and the gamma dose rates fell off quite rapidly during the first years of the existence of the track (Table 3); subsequently the radiation situation was determined by the presence of  $^{90}\text{Sr}$  alone, and by the rate of its radioactive decay [2-4].

Table 3. Time Course of Radiation Situation (cit. [3, 4])

Time after accident, years	Density of contamination, Ci/km <sup>2</sup>		-Dose rate, R/h
	based on total activity of nuclides	based on <sup>90</sup> Sr	
0	1	0.027 (1)	1
1	0.34	0.026 (0.98)	5.6 p10 <sup>-2</sup>
3	0.10	0.025 (0.93)	8.310 <sup>-3</sup>
10	0.043	0.021 (0.78)	9.810 <sup>-4</sup>
25	0.029	0.014 (0.54)	3.810 <sup>-4</sup>

Note: In parentheses, the strontium fraction of the initial content

The irradiation of population in the contaminated territory was caused in the initial period by external irradiation from the soil and from the habitat, including clothing, as well as internal irradiation due to the consumption of contaminated food products and drinking water, and the inspiration of radioactivity at the moment of the formation of the track. In the following period (after 0.5 - 1 year), internal irradiation prevailed as a result of the entry of radioactivity via the diet [2].

The following were undertaken as measures for the radiation protection of the population: Evacuation (resettlement) of the population; deactivation of a portion of

the agricultural territory; monitoring the levels of the radioactive contamination of agricultural production and produce, the discarding of products with levels exceeding the established allowable norms; introduction of a regime for the limitation of agricultural and forestry activities with the creation of specialized state farms and state forests operating on the basis of special recommendations.

The dynamics of the evacuation of the population living on the territory with a density of contamination greater than 2 Ci/km<sup>2</sup> with respect to <sup>90</sup>Sr is presented in Table 4.

Table 4. Time Course of Evacuation of the Population and of the Radiation Exposure Prior to Evacuation (According to the Data of [3, 4])

Group and Size of Population, in Thous.	Average density of contamination, based on <sup>90</sup> Sr, Ci/km <sup>2</sup>	Time of evacuation, days	Average dose received prior to evacuation, cSv	
			external irradiation	EDE
A; 1.15	500	7-10	17	52
B; 0.28	65	250	14	44
C; 2.0	18	250	3.9	12
D; 4.2	8.9	330	1.9	5.6
E; 3.1	3.3	670	0.68	2.3

Soon after the accident, over the course of 7 - 10 days, 1,150 individuals were immediately evacuated; in the following year and a half, about 9,000 individuals, in all 10,730 individuals were resettled. The maximum average radiation doses received prior to evacuation reached 17 rem with respect to external irradiation, and 52 rem with respect to the effective dose equivalent, the EDE (150 rem to the gastrointestinal tract). These doses may be doubled when account is taken of the nonuniformity of the contamination density and the conditions of irradiation.

A mass examination of residents was organized one year after the accident; it included examination by a pediatrician and therapist, a neurologist, and a gynecologist; a blood count and the determination of body weight and growth were examined. Risk factors in relation to the development of oncopathology, cardiovascular pathology, and harmful habits were assessed; the urine

was examined for protein and sugar. The serum cholesterol level was determined; examination by an otorhinolaryngologist was set up, and an electrocardiographic examination was carried out.

The population subjected to maximum radiation effect (group A) was comparatively young: 45 percent, up to 17 years; 39 percent, from 18 to 49 years, and 16 percent, older than 50 years.

Cases of radiation illness were not recorded during the clinical examination of the population. In the early period of the investigation, decreased leukocyte count in the peripheral blood was observed in 21 percent of the cases. However, when the peripheral blood values were examined, it was established that in the adult victims the average platelet counts [ (236-280) 10<sup>9</sup>/l ], leukocyte counts [ (7.2-7.5)10<sup>9</sup>/l ], and neutrophil counts [ (4.1-4.7)10<sup>9</sup>/l ] did not differ from the control values. The

distribution functions of these indices in the period of the initial examination with respect to the median values in the irradiated individuals coincided with the effective values, but among those irradiated, values that were two standard deviations from the mean were observed in a large percentage of the irradiated individuals. Thus, the proportion of individuals with a leukocyte count greater than  $910^9/l$  was 17 - 19 percent, and a platelet count greater than  $35010^9/l$ , 7 - 8 percent.

The reaction of the cardiovascular system to the radiation effect in all the subjects was assessed on the basis of the arterial blood pressure (BP) and the pulse rate (PR).

The results in practically healthy group A individuals (Table 5) show that there is no regular increase in the frequency of deviation in these parameters from the usual distribution and from the radiation dose.

**Table 5. Frequency of Deviations in BP and PR in Subjects of Group A**

Indicator	Fraction of individuals with the given indicator, %
Tachycardia (PR $\gamma$ 90 per min)	5.5 (4-7.4)
Bradycardia (PR $\eta$ 60 per min)	8.5 (0-14.1)
Arterial hypertension (BP $\gamma$ 160/96 mm Hg)	3.3 (1.7-4.0)
Borderline hypertension (BP 140/90-159/94 mm Hg)	10 (7.5-14.5)
Hypotension (BP $\eta$ 100/60 mm Hg)	16.4 (10.8-24)

The testing of the population showed that up to 75 percent of individuals belong to the practically healthy group. General somatic illnesses were identified in 25 percent of subjects. As can be seen from Table 6, among these more than half are accounted for by pathology of the cardiovascular system, and almost 30 percent by diseases of the respiratory organs.

**Table 6. The Character and Frequency of Illnesses in the Subjects**

Class of illnesses and nosological entities	Fraction of individuals with the corresponding diagnosis, %
Parasitic diseases, helminthosis	0.6
Nodular goiter and thyrotoxicosis	0.5
Diseases of the circulatory system:	
rheumatic heart diseases	1.8
hypertensive disease	2.5
ischemic disease	3.3
coronary and cerebral atherosclerosis	5.1
varicose veins	1.0
In all:	13.7

**Table 6. The Character and Frequency of Illnesses in the Subjects (Continued)**

Class of illnesses and nosological entities	Fraction of individuals with the corresponding diagnosis, %
Diseases of the respiratory organs:	
acute nasopharyngitis	5.3
bronchitis	2.3
emphysema	0.7
In all:	8.3

Thus, when healthy inhabitants of the population centers from the head end of the track were examined, clinical manifestations of radiation illness were not established. It may be presumed that some deformation in the distribution of blood counts is associated with the hematological reaction to irradiation noted in earlier periods, leukopenia, relative lymphopenia, and a neutrophilic shift to the left.

In late periods following the accident, a medical examination was carried out of people who might be assigned to the critical group: In them the radiation effect fell in the period of the formation and the establishment of the organism, and the levels of radiation were the highest (group A from Table 4). One third of these people proved to be practically healthy. Foci of chronic infection without exacerbation were established in the rest upon careful examination (18 percent, cases of chronic otitis; 13 percent, cases of chronic tonsillitis; 16 percent, cases of chronic gastritis and cervicitis). The frequency of osteochondrosis increased as age increased. Epilepsy was found in three people on a soil of alcoholism and skull trauma. Specific features were not identified in the morbidity of the irradiated individuals as compared with the control contingent. The peripheral blood counts corresponded to the generally accepted norms. As age increased, the frequency of dystrophic ECG changes increased (classes 4, 5, and 9 in accordance with the Minnesota Code). The frequency of cases of class 0 ECG (without changes) in the irradiated individuals was not less frequent than in the control.

The serum cholesterol content (MA mole/l) of the irradiated individuals did not differ from the control, and was 4.7810.1 for individuals up to the age of 29 years; 5.2510.06 - 4.7810.1, up to 39 years; 5.4110.06, up to 49 years; and 5.6910.06, 50 years and above.

The frequency of some diseases which are risk factors for the occurrence of oncopathology in the irradiated individuals was no higher than in the control. Thus, chronic gastritis, endocervicitis and erosion of the uterine cervix was present in 2.3, 11.1, and 11.1 percent of cases among the 28 year olds, and in 9, 20, and 0 percent of cases in the 50 year olds, respectively. Early childhood mortality and intrauterine developmental anomalies are among the sensitive criteria of injury in response to ionizing radiations. Thirty-five cases of death from congenital anomalies were recorded in a 35 year period in the

offspring of the population living on the territory of the radioactive track, including 10 cases in the first group made up of 10,270 individuals living at levels of 1.2 Ci/km<sup>2</sup> with respect to <sup>90</sup>Sr, and 25 cases in the second group made up of 23,230 individuals (at levels of 0.1 - 1 Ci/km<sup>2</sup> with respect to <sup>90</sup>Sr); there were 29 cases of death in the control group, consisting of 21,537 individuals (less than 0.1 Ci/km<sup>2</sup> with respect to <sup>90</sup>Sr) in the total mortality structure, the mortality rate from developmental anomalies was 0.36 - 0.67 percent (Table 7).

**Table 7. Extensive and Intensive Mortality Rates from Inborn Developmental Anomalies**

Population group	Extensive rates	Intensive rates for 30 years	
		per 100,000	per 1,000 newborns
1st (10,270 individuals)	0.36	4.2	1.02
2nd (23,230 individuals)	0.38	4.2	1.93
control (21,537 individuals)	0.67	7.4	2.66
Population of Chelyabinsk Oblast as a whole:			
for 1965	0.53	3.6	2.3
for 1986	0.23	2.2	1.3

As can be seen from Table 7, the differences in the groups are statistically insignificant. There were also no differences in the first two years after the accident.

The absence of a significant difference in the level of mortality of newborns with developmental defects from 1980 - 1987 per 1,000 newborns should also be noted, although this value was higher in the center closest to the source of the radiation [1]: overall, it was 0.9510.08 in relation to the zone of influence (rayons of Chelyabinsk Oblast, in the zone in which nuclear industrial enterprises were located); in the closest population center (an

urban settlement; the calculated radiation dose over 40 years was 170 mSv), it was 1.710.4; in Chelyabinsk Oblast, it was 1.010.8; in Sverdlovsk Oblast, 1.110.07. The cause of this increase has to be elucidated.

Highly specific data were obtained when early childhood mortality was analyzed in the first years following the accident (Table 8).

**Table 8. The Mortality of Children up to 1 Year of Age in the Period from 1957 Through 1961 per 1,000 Newborns**

Causes	Territory of the track	Control 1 at the boundary of the track	Control 2 at a great distance from the boundary of the track
All causes	27.7	31.4	38.6
Feeding disturbance	15.212.8	12.313	511
Pneumonia	1.711.0	3.111.5	16.111.8
Infections	1.610.9	2.311.3	3.010.8
Disease of the newborn	8.712.2	13.813.2	14.511.7

As can be seen from Table 8, there is no fundamental difference in early childhood mortality in the three groups compared, even against the background of the high mortality encountered in those years. The causes of the early childhood mortality are not associated with the levels of radiation effect, but are apparently brought about by the uneven medical servicing of newborns.

The remote consequences of the irradiation of the population were studied concurrently among the irradiated and control contingents, as well as in the zone of influence of the nuclear industrial enterprise. Therefore, more than 100,000 individuals were placed under observation. The results of the radiological effect on the contingent which had been irradiated to the highest degree are presented in Table 9. Intensive mortality rates among this contingent were 272, 2,760, 6,578, and 5,873 cases in group A and the first, second, and control groups, respectively, and the corresponding mortality rates were 9.5, 11.5, 11.0, and 10.9 per 1,000. As can be seen, there are no differences from the control.

**Table 9. Size of Irradiated Population and Average Absorbed Dose**

Group	Number of residents	Duration of irradiation	Average doses, cSv					
			external radiation	internal radiation			EDE	
				gastrointestinal tract	lungs	red bone marrow		osseous surfaces
A	1,150	10 days	17	150	2.7	0.5	0.7	52
1st	10,270	30 years	0.4	2	0.2	3.8	5.2	2
2nd	22,230	30 years	0.1	0.7	0.1	0.7	1.0	0.4
Control	21,537	30 years	Q	Q	Q	Q	Q	Q

At the same time, age-specific mortality rates deviate substantially from the control up to 4 years of age and beyond 60 years of age. However, it was not possible to discover any association with the radiation dose. Thus, the mortality rate in group A and the first, second, and control groups up to the first year was 91, 32, 63, and 52; from the first to the fourth year, 13.7, 1.7, 5.0, and 3.3; and after sixty years, 39.2, 50.4, 43.1 and 46.9, respectively. The age-specific mortality rate and the control mortality rate did not differ between the groups and the control in all other age groups.

It should be noted that, among 272 individuals from group A who died, oncological morbidity is not in second place, but in third place following cardiovascular disease and trauma and accidents. The predominance of mortality from infectious diseases over mortality from diseases of the respiratory organs is another peculiarity.

The analysis of mortality from malignant tumors is of the greatest interest, since it is the principal manifestation of preceding irradiation in the remote period. The highest mortality rates, at the border of significance, were observed in the inhabitants of the first group (Table

10). However, the sample was insignificantly large to permit the assertion of a significant difference between the observed values.

**Table 10. Extensive (in Percents) and Intensive (Per 100,000) Mortality Rates from Malignant Tumors for 30 Years**

Population group	Number of cases			Confidence intervals, 95%
	abs.	%	per 100,000	
A	25	11.7	115.9	75-165
1st	376	13.6	157.4	142-174
2nd	775	11.8	129.2	120-139
Control	707	12.0	131.9	122-142

Cancer of the digestive organs, and among these, cancer of the esophagus, occupies a substantial position in the structure of the neoplasms over the extent of the entire period of observation (Table 11). It appears as if a trend toward an increase in the frequency of cancer of the esophagus can be observed in group A of the population, which is highest with respect to the radiation dose, although this increase is statistically not significant.

**Table 11. The Structure of Mortality from Malignant Neoplasms (Per 100,000)**

Principal localizations	International nomenclature code	Groups of irradiated individuals			
		A	1st	2nd	Control
Esophagus	150	26.5	8.2	11.3	12.1
Stomach	151	35.3	45.1	32.4	44.3
Other digestive organs	152-159	8.8	30.7	20.9	22.4
Respiratory organs	160-163	17.7	29.5	24.9	26.4
Bones	170	0	3.1	0.9	2.4
Skin, oral cavity	140-147	0	7.5	1.4	4.5
	172-173				
Mammary gland	174	4.4	4.4	2.1	4.2
Uterine body and cervix	180-182	0	13.1	9.6	10.8
Other genitourinary organs	183-189	4.6	9.4	6.6	7.6
Lymphatic and hematopoietic organs	200-209	13.2	5.0	5.2	4.7

Lethal cases of neoplasms of the lymphatic and hematopoietic tissues were of interest. The mortality rate in dose group A was  $13.2 \cdot 10^{-5}$  as against  $4.7 \cdot 10^{-5}$  in the remaining groups, although the differences were not significant, since the figures were based on three fatal cases, yet it should be noted that the EDE in this group was 52 cSv, which is close to the critical dose for the induction of the leukemias.

The mortality level from malignant diseases by decades is presented in Table 12 for the zone of influence of the track, in comparison with the intensive rates for the neighboring oblasts, Chelyabinsk being the first, and Sverdlovsk, the second. The data of Table 12 show that the mortality increased with each succeeding decade. The lower mortality figure in the nearest population center is associated only with the lower age of the population in it.



**Table 12. Level of Mortality from Malignant Neoplasms (Per 10,000 Individuals)**

Years	Overall for the zone of effect*	At the nearest population center*	In Chelyabinsk Oblast	In Sverdlovsk Oblast
1970-1980	145.8	Q	146.6	Q
1980-1987	160.712.5	105112.7	167.613.2	159.416.6

\*See explanation earlier in the text on p. 6.

Analysis of the causes of mortality from malignant neoplasms in connection with the radiation accident allowed us to group the frequency of tumors diagnosed for the first time depending upon several factors of external influence. Based on the example of mortality in Chelyabinsk Oblast, the following was found: There is no connection detected between the increased frequency of morbidity and the exposure dose rate; a complete correlation of the frequency of diseases with the discharges of SO<sub>2</sub> into the atmosphere was established; although SO<sub>2</sub> is not a carcinogen, it is very convenient as an indicator of overall chemical pollution. The actual data show that if SO<sub>2</sub> is not discharged, the morbidity rate is 225 cases; if the discharges of SO<sub>2</sub> are 50,000, 100,000, and 150,000 tons per year, the morbidity rate is 250, 275, and 300 cases per 100,000 per year. Therefore the frequency of mortality from malignant diseases on the map of Chelyabinsk Oblast correlates not with the track of radioactive contamination, but with the location of enterprises of the metallurgical and chemical industries.

A great deal of attention was devoted to the status of the reproductive function of the irradiated individuals at various ages. The data of Table 13 show that systematic deviations of this most important demographic indicator could not be found in individuals who had received the highest dose. As can be seen from Table 13, marriage by the age of 27, and correspondingly, the absence of children in the families, was found in those who were newborn at the time of the accident. In older individuals, to the contrary, the frequency of entrance into marriage was higher than in the control, and the number of children either did not differ from the control, or was somewhat less than in the control (age at the time of the accident up to 9 years). At the same time, the dynamics of the birth rates by years per 1,000, as can be seen from Table 14 is higher than for the oblast as a whole. The impression is created that the conditions of life and social factors in the population that was resettled earlier were somewhat better than in the remaining rural population of the oblast. It may be that some other factors, perhaps ethnic characteristics, have played a role.

**Table 13. Percent Married and the Presence of Children in Irradiated Parents**

Group of subjects	Age at the time of accident, years	Total subjects	Percent married	Percent having children
Newborns	Up to 1	56	91 (82-97)	84 (73-92)*
Children	1-9	295	93 (89-96)*	90 (86-93)*
Adolescents	10-19	203	93 (89-96)*	93 (89-96)
Adults	20-29	201	95 (92-98)*	91 (87-94)
	30-59	308	98 (96-99)*	98 (96-99)*
Control, USSR			81.9-82.6	94.6

\*Differences from the control significant.

**Table 14. Dynamics of the Birth Rates in the Evacuated Population (Per 1,000)**

Parameter	Time after accident, years							
	1	5	10	15	20	25	30	1-30
Number of children	51	271	491	717	960	1242	1586	1616
Birth rates	37.4	42.2	30.2	27.5	26.4	27.8	30.0	31.8
Standardized rates	40.4	48.7	31.8	26.9	24.8	26.2	26.6	31.8
Birth rates for Chelyabinsk Oblast	24.1	20.8	14.8	16.0	16.7	19.8	16.7	18.4

### Conclusion

It should be noted that when the state of health, the morbidity, and mortality of the population subjected to an accidental radiation effect with irradiation levels based on EDE from 1 to 52 cSv, at an irradiation level of individual organs up to 150 cSv, were observed, deviations were not detected from analogous indices in non-irradiated individuals.

### Footnotes

1. L. A. Buldakov, S. N. Demin, N. A. Koshurnikova, *Atomnaya Energiya*, 1989, Vol. 67, No. 2, pp. 81-83.
2. Results of a Study and Experience with the Elimination of Accidental Contamination of a Territory by the Products of Uranium Fission, A. I. Burnazyan (ed.), Moscow, 1974.
3. B. V. Nikilepov, G. N. Romanov, L. A. Buldakov, et al., The Accident in South Urals on September 29, 1957. Interdepartmental Council on Information and Communications with the Public in the Field of Atomic Energy, Inform. Byul., Moscow, 1989.
4. B. V. Nikilepov, G. N. Romanov, L. A. Buldakov, et al., *Atomnaya Energiya*, 1989, Vol. 67, No. 2, pp. 74-80.

### Radiation Meeting Reports

#### The First All-Union Scientific Conference on Radiology of Students of Medical Institutes

917C0205C Moscow *MEDITSINSKAYA RADIOLOGIYA*, in Russian Vol 35 No 12, Dec 90 pp 50-51

[Article by A. A. Filatov (Moscow)]

UDC 615.849.+616-073.75+616-073.916]:061.3-057.875(47+57) G1990H

[Text] The First All-Union Scientific Conference of Students of Medical Institutes, devoted to urgent problems of contemporary radiological diagnosis and radiation therapy, was held May 15-16, 1990, in Obninsk, based at the Scientific Research Institute of Medical Radiology, USSR Academy of Medical Sciences. The organizers of this conference were the Ministry of Health of the USSR, Scientific Council on Medical Radiology and Radiological Diagnosis of the USSR Academy of Medical Sciences, the Scientific Research Institute of Medical Radiology, USSR Academy of Medical Sciences, and the Department of Roentgenology and Radiology of the I. M. Sechenov First Moscow Medical Institute.

It should be noted that the conference continued the traditions of inter-institute scientific conferences (which until recently were regional in character) on a wider scale.

About 60 students participated in the work of the conference: Members of student scientific societies, departments, and courses of roentgenology and radiology from various regions of the country, including the European portion of the Russian federation, Siberia and the Far East, the Ukraine, Belorussia, and the republics of Central Asia.

The materials of the conference, published in the form of a collection of abstracts, attest to the quite high methodological level of many studies, and to the broad spectrum of scientific interests of the students and participants in special interest circles. Twenty-six reports were heard at the conference itself. These were all carried out at an excellent scientific methodological level, and were up to date in content. Studies done by participants in special interest circles from Moscow, Leningrad, Kiev, Kuybyshev, Omsk, and Dushanbe should be noted in particular.

In addition to the official portion, the students participated in the nonofficial portion of the conference program as well. The leadership of the Institute organized excursions through various clinical-diagnostic subdivisions of the Institute, where the students were acquainted with the newest and most promising methods of radiological diagnosis and radiation therapy.

The excursion to the computer center, where scientists were developing monitoring programs, and creating radiation medicine data banks with the aim of reducing the medical sequelae of the accident at the Chernobyl atomic power station to a minimum, made a special impression on the students. Prof. A. I. Shekhter presented a lecture to the students on the scientific methodological foundations of the organization and the working principles of the diagnostic centers.

The best reports were recognized by commemorative prizes at the concluding portion of the conference. The high organizational level of the conference was recognized in a resolution passed, and the desire of interested participants for the continuation of such student meetings was also expressed. The next conference will be held in 1993, and in 1995 it will be devoted to the 100th anniversary of the discovery of the x-rays.

A. F. Tsyb, Director of the Institute and Corresponding Member of the USSR Academy of Medical Sciences, and Professors I. S. Amosov, I. P. Korolyuk, L. D. Lindibraten, and A. I. Shekhter participated in the work of the conference.

The All-Union Scientific Association of Roentgenologists and Radiologists, and the "Diagnost" ["Diagnostician"] Collective under the aegis of the Scientific Research Institute of Medical Radiology, USSR Academy of Medical Sciences, were the sponsors of the conference.

**Information Regarding the Creation, Under the Aegis of the WHO, of an International Program on the Medical Consequences of the Chernobyl Accident, and of an International Center for Radiation Medicine Problems (Obninsk)**

[Article by A. A. Filatov (Moscow)]

UDC 614.876:614..83] GChernobylH  
[614:061.14(100)]

[Text] From April 19 through April 27, 1990, experts from the Soviet Union and the Secretariat of the WHO discussed various possibilities for the expansion of collaboration relating to the medical consequences of the Chernobyl accident. On the basis of these discussions, the WHO and the Ministry of Health of the USSR agreed in principle on the following.

1. A long-term global international program will be created under the aegis of the WHO for monitoring the effects of the accident on health and for reducing these effects to the minimum. In addition, this program will promote the maintenance of health and preparedness for extreme situations.
2. The program will encompass the following principal areas: epidemiological investigations using existing registers and the organization of long-term evaluations of irradiated individuals; the diagnosis, treatment, and prevention of diseases of the thyroid gland caused by radiation, especially in regions endemic for goiter; carcinogenic and teratogenic effects; genetic effects; the contribution of radiational and nonradiational causative factors to morbidity and mortality; the social and psychosocial aspects of the accident and their influence on health; the retrospective analysis of the levels of radiation effect and predicted doses; international expert consultation for independent assessments of the radiation hygienic situation, and for radiation protection and population health measures; radiation medicine data banks.
3. An International Center for Radiation Medicine Problems will be established for the efficient implementation of the program on the basis of voluntary contributions of interested governments, organizations, institutions, and scientists.
4. All efforts will be undertaken to insure participation as well as financial and technical support on the part of interested governments, institutions, and scientists.
5. The WHO will develop and coordinate the participation of governments and international organizations, will coordinate the mobilization of resources for the program, and will provide practical support and make recommendations in the area of its competence, for example, with respect to the epidemiological investigations of oncological diseases carried out by the IARC.
6. The program will be carefully coordinated at the national and international levels with other efforts along these lines that are already in existence or are planned.

7. The USSR will provide the initial material base and certain basic support projects for the creation of the International Center for Radiation Medicine Problems.

8. A scientific consultative committee should be formed to define the general recommendations of participants in the program.

9. Starting in June 1990, with financial support from the WHO, the preparatory phase of the program will begin. In the course of this phase, the program will be completed, the working plan put together, the initiative group of participants and the financial resources will be determined, the priorities definitively established, and a position regarding the center will be prepared. The duration of the preparatory phase will be approximately 12 months.

On April 30, 1990, the Deputy Minister of Health of the USSR, A. I. Kondrusev, and the General Director of WHO, Kh. Nakadzima, signed a memorandum of agreement between the Ministry of Health of the USSR and WHO regarding the efforts to be directed toward the reduction of the medical effects of the Chernobyl accident to a minimum and regarding the creation in Obninsk of an International Center for Radiation Medicine Problems (the memorandum is attached). A package of documents on the international program and the center was developed by a group of experts of the USSR and the WHO.

- I. Substantiation of the international program.
  - II. The aims of the program.
  - III. The basic directions of the program:
    1. Epidemiology.
    2. The prophylaxis, diagnosis, and therapy of diseases induced by irradiation.
    3. Protection of maternal and child health.
    4. The role of social and psychological factors in the state of health of the population.
    5. Demographic research.
    6. Radiation medicine data banks.
    7. Biological indication and dosimetry.
    8. Radiobiology.
    9. Radiation dosimetry.
  - IV. The WHO plan for the initiation of the program (1990-1991).
  - V. The International Center for Radiation Medicine Problems (Obninsk).
  - VI. Expected results of the program:
    1. The health of the population.
    2. The utilization of the experience.
    3. Scientific investigations.
- The International Program on the Medical Consequences of the Chernobyl Accident is appended.

**New Institute of Gene Biology Opens**

907C0673A Moscow *PRAVITELSTVENNYY*  
*VESTNIK in Russian No 16, Apr 90 p 3*

[Article by A. Karavayev: "There Will Be A New Institute"]

[Text] The study of genes makes it possible to understand the nature of basic biological phenomena and to comprehend their minute and delicate mechanisms. The Department of Molecular and Genetic Problems of the N. I. Vavilov Institute of General Genetics and the Laboratory of Biosynthesis of Nucleic Acids of the V. A. Engelgardt Institute of Molecular Biology have been working on that area of research in our country. In order

to expand the scope of the research in this area, the Council of Ministers of the USSR has accepted the proposal of the USSR State Committee for Science and Technology and of the USSR Academy of Sciences concerning the creation of the new Institute of Gene Biology of the USSR Academy of Sciences, based on the above-mentioned department and laboratory. The word "expand", however, does not pertain to the staff; it will be a small mobile group—a total of about 60 people.

The main areas of the research in the new institute will be the study of the mechanisms for the regulation of gene functioning for the purpose of controlling genetic processes, aging processes, and the occurrence of tumors and metastases, and for antitumor protection.

**Reliability of Human Performance in Automated Systems and Its Qualitative Evaluation. Conceptual Model of Performance Reliability**

907C0841 Moscow *PSIKHOLOGICHESKIY ZHURNAL* in Russian Vol 11 No 3, May-Jun 90 pp 60-69

[Article by V. Yu. Shcheblanov, candidate of biological sciences, laboratory chief, and A. F. Bobrov, mathematician, group leader, Institute of Biophysics, USSR Ministry of Health, Moscow]

[Abstract] A new conceptual model was proposed for the reliability of human performance with automated systems; according to this the performance reliability is

characterized by its results and by the psychophysiological "cost" of achieving a given goal. A method was developed for quantitative evaluation of those "costs" and for the performance reliability. Practical application of the approach in analytical medical complexes should make it possible to evaluate and predict individual reliability of human performance in a real situation and detect the functions of organisms whose stress will increase the psychophysiological "cost" of a given activity, lowering its reliability. That should make the planning, organization and realization of recovery-rehabilitation measures more practical, supporting the necessary level of functions, assuring completion of a given activity. Overall, the reliability of human performance should increase throughout the entire automated system. Figures 2; references 25: 20 Russian, 5 Western.

**Dynamics of Antibody Formation to a Vaccine Strain of *Francisella Tularensis* in Different Immunization Schemes**

907C0719D Kiev *MIKROBIOLOGICHESKIY ZHURNAL in Russian Vol 52 No 2, Mar-Apr 90 pp 89-93*

[Article by I. Ya. Cherepakhina, V. N. Kozlovskiy, Ye. A. Yefanova, A. S. Novokhatskiy, L. P. Alekseyeva, V. V. Sukhar, L. A. Prozorova, L. V. Larionova, V. M. Sorokin, and L. K. Lysova, Scientific Anti-Plague Research Institute, Rostov-na-Donu]

UDC 579.841.95.083.3

[Abstract] Production of monoclonal antibodies (MA) to antigenic determinants of bacterial and viral disease pathogens is directly related to the selection of an optimal immunization scheme providing a high titer of antibodies. The real problem in producing MA to tularemia pathogen is that mice are poor producers of antibodies to tularemia microbes. A special study was undertaken to find an optimal method for the production of such antibodies. In all, 1,500 mice were used in a number of experimental variations showing that intraperitoneal injection of live vaccine of *F. tularensis* during three consecutive days at a dose of 1 - 100 µg resulted in the optimal production of antibody titer. The level of antibodies was maintained for 15 - 20 days, and then it gradually dropped to zero around the 50th day. A triple injection into the spleen with a 10 day interval between the injections also gave excellent results. Revaccination of mice with the background of a high MA titer lowered the number of MA. With a background of low titer, however, revaccination always led to a booster effect producing a higher titer of MA. Figures 4; references 8: 1 Russian, 7 Western.

**Immunologic Control During General and Specialized Physical Training**

907C0858A Moscow *TEORIYA I PRAKTIKA FIZICHESKOY KULTURY in Russian No 6, Jun 90 pp 17-19*

[Article by Ye. N. Antropova, P. N. Uchakin, I. Ye. Vorotnikova, and A. V. Ovsyannikov, Institute of Biomedical Problems, USSR Ministry of Health, Moscow]

[Abstract] The goal of this work was to evaluate integral indices of the immune system during a specialized and general physical training period. In all, 17 men aged 25 - 42 were studied. None of them was an active sportsman; their training lasted for two hours a day, three days a week, for a period of two months. The general physical training group exhibited no changes from the normal immunologic status during the entire study period. Those participating in the specialized training showed lower levels of T-lymphocytes during the first 30 days of the adaptive period along with depressed activity of the immunocompetent cells. These indices returned to normal towards the end of the training period. It was concluded that during development of complex physical training program, it is necessary to evaluate the adequacy of the immunologic status of the subjects. References 15: 9 Russian, 6 Western.

**Therapeutic Efficacy of Domestically Produced Reaferon in Hairy Cell Leukemia**

907C0858B Moscow *GEMATOLOGIYA I TRANSFUZIOLOGIYA in Russian Vol 35 No 6, Jun 90 pp 16-19*

[Article by M. A. Grigoryeva and Doctor of Medical Sciences A. M. Polyanskaya, All Union Scientific Center of Hematology, USSR Ministry of Health, Moscow]

UDC 616.155.392.2-036.12-085.339:578.245]-036.8

[Abstract] The goal of this study was to clinically evaluate the efficacy of the treatment of hairy cell leukemia with the  $\alpha_2$ -interferon produced by the Main Administration "Biopreparat" of the Ministry of Medical and Microbiological Industry. The study included 16 patients (12 men, 4 women) aged 33 - 51. Overall, 10 out of these 16 patients showed positive results lasting from two weeks to four months; one patient showed complete remission lasting for four months. The drug was tolerated well, with reasonably good antitumor effect. However, because of the unstable clinical-hematologic effect of reaferon, the maintenance therapy protocol should be modified along with possible combination therapy including other cytostatic reagents, splenectomy, etc. Figures 1; references 18: 2 Russian, 16 Western.

### Efficacy Helium-Neon Laser Irradiation of Blood in Acute Myocardial Infarction

907C0777A Moscow SOVETSKAYA MEDITSINA  
in Russian No 3, Mar 90 pp 9-12

[Article by N. N. Kipshidze, G. E. Chapidze, M. R. Bokhua, L. A. Marsagishvili, N. S. Salukvadze, N. K. Dolidze, and T. S. Revishvili, Scientific Research Institute of Experimental and Clinical Therapy, Georgian SSR Ministry of Health, Tbilisi]

UDC 616:127-005.8-036.11-085.849.19

[Abstract] Therapeutic trials were conducted on 295 patients with acute transmural myocardial infarction to assess the efficacy of endovascular blood irradiation with a helium-neon laser (LG-75) on the clinical course. The laser procedure was performed for 25 - 30 min per day for 3 days with constant EKG and blood chemistry monitoring. The results demonstrated complete alleviation of pain within 10 - 30 min of irradiation in 33 percent of the patients and partial attenuation in 29 percent, with the remaining subjects requiring pain control. Helium-neon laser therapy was also found effective in controlling arrhythmia and extrasystoles in some 50 - 70 percent of the patients, with none of the laser-treated group developing ventricular fibrillation. In addition, laser therapy also facilitated a more rapid reduction in blood creatine kinase activity. Accordingly, endovascular irradiation of blood by helium-neon laser was shown to attenuate pathogenetic mechanisms of myocardial infarction and thereby limit the extent of myocardial necrosis. References 7: 3 Russian, 4 Western.

### Helium-Neon Lasers in Combined Therapy of Unstable Angina Pectoris

907C0777B Moscow SOVETSKAYA MEDITSINA  
in Russian No 3, Mar 90 pp 12-15

[Article by I. M. Korochkin, G. M. Kapustina, Ye. V. Babenko, and N. Yu. Zhuravleva, Faculty of Therapeutics Chair, Pediatrics Faculty, Second Moscow Medical Institute imeni N. I. Pirogov]

UDC 616.12-009.72-085.849.19

[Abstract] Therapeutic trials were conducted on the efficacy of helium-neon laser irradiation in the management of unstable angina pectoris in combination with chemotherapy. The study was conducted on 105 patients with various forms of angina pectoris. In the experimental group, laser therapy involved endovascular blood irradiation (45 min; 4 - 6 procedures) alone or in conjunction with cutaneous irradiation of Zakharyin-Head points (0.6 - 0.8 mW/cm<sup>2</sup> for 1 min, 6 - 8 procedures). Monitoring of the clinical status of the patients and blood coagulation demonstrated that helium-neon laser therapy was beneficial in alleviating the danger of thrombosis. In particular, laser therapy led to a reduction in fibrinogen levels and normalization of

antithrombin III, in the absence of meaningful changes in plasminogen levels. The study also revealed that endovascular irradiation was indicated in patients with low levels of antithrombin III, while endovascular + cutaneous irradiation was deemed best for patients with either normal or elevated levels of antithrombin III. In addition, these observations suggest that blood coagulation factors may serve as indicators of the efficacy of laser therapy. References 13: 6 Russian, 7 Western.

### Blood Irradiation by Low Intensity Lasers in Myocardial Infarction

907C0777C Moscow SOVETSKAYA MEDITSINA  
in Russian No 3, Mar 90 pp 18-21

[Article by Yu. N. Sirenko, S. Yu. Savitskiy, S. S. Krasnitskiy, A. V. Shabilyanov, and L. I. Popova, Kiev Scientific Research Institute of Cardiology imeni N. D. Strazhesko, Ukrainian SSR Ministry of Health]

UDC 616.127-005.8-085:616.15-02:615.849.19.03

[Abstract] Endovascular helium-neon laser irradiation of the blood was assessed for its clinical benefit in a group of 119, aged 28 - 66, men with myocardial infarction. The experimental group received laser therapy with LG-75 and LGN-11 lasers with a power output of 2 - 2.5 mW for 40 min per day for 3 - 5 days. The beneficial effects of this therapy were evident in the fact that the mortality rate for the experimental group was 2 percent, while that of the control group was 9.5 percent. In addition, laser treatment alleviated pain, had an antiarrhythmic effect, limited the extent of necrosis and served to reduce the incidence of vascular insufficiency to 6.6 percent versus 35.1 percent for the control patients. Biochemical studies demonstrated that in addition to inhibition of the pituitary-adrenal axis, laser therapy served to attenuate factors related to vasospasms and thrombosis (vasopressin, angiotensin II, renin, and PGF<sub>2α</sub>), while favoring elevation of factors favoring vasodilation and hypocoagulability (PGE<sub>1</sub> and PGI<sub>2</sub>). References 10: 8 Russian, 2 Western.

### Clinical Aspects of Laser Therapy in Ischemic Heart Disease

907C0777D Moscow SOVETSKAYA MEDITSINA  
in Russian No 3, Mar 90 pp 51-52

[Article by V. A. Larionov, Ye. A. Stroyev, P. G. Shvalb, V. G. Makarova, V. G. Okorokov, M. I. Katayev, G. O. Ivanova, A. A. Sigayev, and L. P. Kalinina, No 2 Chairs of Therapy and of Biochemistry, Ryazan Medical Institute; Ryazan Oblast Center of Vascular Surgery]

UDC 616.127-005.4-085.849.19-036.8-07

[Abstract] The effects of endovascular and cutaneous helium-neon laser therapy in the management of ischemic heart disease were studied on 216 men and

women. Conventional laser treatment modalities were employed, with the demonstration that irradiation of reflexogenic Zakharyin-Head points had a beneficial effect in subjective and objective terms. In addition, endovascular blood irradiation was shown to significantly improve microcirculation and stimulated leukocytic  $\beta$ -galactosidase activity. In general, endovascular

irradiation was of greater benefit than cutaneous irradiation in the treatment of ischemic heart disease, and was particularly effective in diabetics in preventing capillary damage as a result of activation of  $\beta$ -galactosidase. Optimum therapeutic benefit was derived in cases in which endovascular irradiation was initiated in the early stages of infarction. References 7: Russian.



### **Inhibitory Effect of Dalargin, a Synthetic Analog of Leu-Enkephalin, on Carcinogenesis**

907C0830A Leningrad VOPROSY ONKOLOGII  
in Russian Vol 36 No 2, May 90 pp 556-559

[Article by V. N. Anisimov and S. M. Bortkevich, Order of the Labor Red Banner Scientific Research Institute of Oncology imeni Professor N. N. Petrov, USSR Ministry of Health, Leningrad]

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[Abstract] In recent years, many investigators have directed their attention towards the role of endogenous opiates in the modulation of neuroendocrinologic and immune systems. A synthetic analog of leu-enkephalin—dalargin (Tyr-D-Ala-Gly-Phe-Leu-Arg)—exhibits a wide range of physiologic properties; it stimulates regeneration of damaged tissues and is effective in treating duodenal ulcers as well as the alcoholism syndrome. In the work reported here, the anticarcinogenic property of dalargin was investigated on female rats injected with 50 mg/kg of nitrosomethylurea (NMU). One year after injection of NMU, 11 of the 16 rats survived in the group receiving dalargin, while only 1 of 17 survived in the control group. Dalargin's effect was manifested primarily by an increase in the tumor latency period. In the control group, 84.6 percent of the animals died as the result of tumor growth, while in the dalargin group only 20 percent of the developed tumors were fatal. The frequency of leukemia was diminished in the dalargin group; however, dalargin had no effect on the incidence of other tumors. An assumption was expressed that the carcinogenic activity of dalargin was due to its effect on the neuroendocrinologic system, possibly analogously to other immune modulators, such as interleukin. Figures 1; references 10: 5 Russian, 5 Western.

### **Alleviation of Acute Hepatic Insufficiency by Hepatocytes Cultured on Microcarriers**

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[Abstract] Hemoperfusion columns packed with hepatocytes adsorbed to Biosilon were tested for their potential therapeutic benefit in 300 - 350 g male Wistar rats with experimental acute hepatic insufficiency (AHI). AHI was induced either by administration of carbon tetrachloride

(3 ml/100 g of 8 percent solution; i.p.) or d-galactosamine (2.5 g/kg, i.p.), resulting in a 95 - 100 percent mortality rate in 40 - 48 h. Hepatocytes cultured on the microcarrier retained an albumin production rate of 120 µg/10exp6 cells/24 h and a rate of bilirubin conjugation of 25 µg/10exp6 cells/h for 4 - 5 days. Hemoperfusion was started 20 - 24 h after hepatotoxin administration and continued for 3 h at a flow rate of 60 ml/h, employing microcolumns packed with 2 ml of 40 x 10exp6 of immobilized hepatocytes. In the carbon tetrachloride study the mortality was reduced to 20 percent in the 48 - 74 h period and to 40 percent by day 7. The corresponding figures for the d-galactosamine experiment were < 40 percent in both time frames. The beneficial effects of this modality were attributed to simultaneous removal of toxic metabolites and delivery of regeneration-promoting factors synthesized by hepatocytes cultured on the microcarrier. Figures 3; tables 1; references 10: 2 Russian, 8 Western.

### **Thyroid Hormone Correction of Stress Factor Disturbances in Ultrastructure of Hypertrophied Myocardium**

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[Abstract] Changes in the ultrastructure of cardiomyocytes in the hypertrophied heart following immobilization stress and the feasibility of correcting the resultant problems with low doses of thyroid hormones were investigated in rats. In hypertrophy of the myocardium, mitochondria appeared in the cardiomyocytes coating areas of the matrix and homogenization of the cristae, the sarcoplasmic reticulum was dilated, hypertrophied myofibrils were fragmented, and glycogen inclusion was elevated. Stress, in addition to hypertrophy, resulted in the appearance of polymorphic mitochondria with disturbances in the cristae structure. The hypertrophied myocardium of the animals, pretreated with thyroid hormones prior to stress, exhibited less fragmentation and homogenization of the mitochondrial cristae. In addition, the cardiomyocyte nuclei contained uniformly distributed chromatin and exhibited less dilation of the sarcoplasmic reticulum elements. These findings suggest that stress in the hypertrophied heart worsens the damage to a number of organelles, while pretreatment with thyroid hormones inhibits the degeneration and enhances the development of regenerative and adaptive processes by increasing the number and size of the mitochondria and cristae in them, the sarcoplasmic reticulum, and glycogen granules. The results also indicate that thyroid hormones elevate the energy supply to

the contracting elements, to the ion pumps of the cytomembranes, and to the sarcoplasmic reticulum in addition to increasing the effectiveness of oxygen uptake. In conclusion, low doses of thyroid hormones are recommended for therapy due to their protective effect on the ultrastructure of the hypertrophied heart following stress. Figures 1; tables 1; references 14: 11 Russian, 3 Western.

### The APUD System and Prospects for the Use of Neuropeptides in Clinical Practice (review of the literature)

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[Article by A. A. Pisarev and L. M. Kirichek; Kiev Scientific Research Institute of Pharmacology and Toxicology]

UDC 612.43/.45+616.43+615.24

[Text] The concept of the APUD system, a neuroendocrine cell organization, the principal features of which are the deposition of precursors of the biogenic amines, their subsequent decarboxylation, and the elaboration of the biogenic amines or polypeptide hormones, was first proposed in 1966 - 1968 by Pearse. Many researchers have taken up its study; it is one of the fundamental problems of biology and medicine. The term APUD system is derived from the first letters of the English words, Amine Precursor Uptake and Decarboxylation, which denote the basic designated features of these cells [18]. The cells of this system are observed in various organs, both those associated with the endocrine functions, and those which are not responsible for endocrine metabolism. The APUD cells have been identified in the pineal, hypophysis, thyroid gland, and parathyroid glands, digestive tract, pancreas, adrenals, lungs, trachea, heart, and other organs [18, 20].

In producing the biogenic amines and peptide hormones, these cells (the apudocytes), play an important role in the maintenance of homeostasis [19]. The peptides may act on endocrine, neurocrine, paracrine, and mediator-type target cells [47]. Disruption of the structure and function of individual cells of the APUD system leads to dysfunction of the entire system and is expressed in apudopathy [18]. Any factor eliciting disruption of subcellular, cellular, or tissue organization can be an etiologic factor in the latter. Disturbances in the synthesis and metabolism of those hormones and biogenic amines which are elaborated and deposited by the apudocytes underlie the pathogenesis of the apudopathies [18, 25, 37].

The apudopathies have been divided into the primary and secondary. The primary apudopathies are associated with the disruption of the structure and function directly off the individual apudocytes. The secondary apudopathies are the result of the reaction of apudocytes to

changes in homeostasis elicited by a disease the pathogenesis of which is not primarily associated with the disruption of the APUD system [20].

The clinical picture and the morphology of the primary and secondary apudopathies (Marburg pineal liposis, Engel-Recklinghausen disease, various forms of gastritis and cholecystopancreatitis, Pellizzi's syndrome, hypoparathyroid tetany, postresectional dysfunction of the stomach and intestine, diabetes mellitus, etc.) have been described in the works of a number of authors [15, 20].

The apudocytes may induce the development of tumors, the apudomas. Paraneoplastic processes, which in the majority of cases are not considered to be symptoms, accompanying a neoplasm, on detailed analysis frequently seem to be secondary apudopathies. The data of the literature [17, 20] indicate a direct connection of a number of paraneoplastic syndromes with a change in the content of serotonin, melatonin, catecholamines and their metabolites, as well as of other products of the APUD system in the organism of oncological patients.

The participation of the APUD system in the endogenous of tumor growth is evidently of great significance. It is known that serotonin, melatonin, histamine, insulin, and epinephrine exert an inhibitory effect on cell proliferation [51, 54], while glucagon and gastrin are capable of increasing the rates of cell division in the organism [49, 52].

The endocrine disturbances observed in lung cancers, in particular the increase in the activity of ACTH in the tumor tissue as well as in the blood plasma, are associated with the presence of tumor endocrine APUD systems [10, 30]. The respiratory difficulties in lung cancer patients have been explained by a change in the correlative relationships between alveolar ventilation and the hemodynamics in the vessels of the lesser circulation. It is assumed in this connection that local adaptation of blood flow in the pulmonary acini to the existing ventilation is one of the functions of the apudocytes in the lungs [5].

The cells of the APUD system in the lungs are of significance not only for tumor growth, but in other pathological disturbances as well. Thus, according to the data of N. I. Bubnova [6], the morphofunctional immaturity of the lungs, one of the features of which is the presence of a large number of APUD cells containing serotonin, is a principal cause of the morpho- and pathogenesis of hyaline membrane diseases of newborn children.

The influence of peptides produced by cells of the APUD system on the organism is so great and diverse that it is easy to observe their significance in a number of pathological conditions. Thus, melatonin, which is found in the pineal, possesses diverse physiological properties: It intensifies metabolic processes, controls pigment metabolism, regulates diurnal and seasonal rhythms, exerts an

antigonadotrophic effect and a sedative and hallucinogenic action, inhibits cell proliferation, decreases the production of somatotrophic hormone and the concentration of insulin in the blood, but increases it following a glucose load [3]. Some authors [42] suggest not calling this class of biologically active substances neuropeptides, but regulatory peptides.

The association of the function of the thyroid's C-cells and the digestive tract's cells that produce peptides, which permits them to be considered a unified APUD system, represents definite practical and theoretical interest. The calcitonin produced by the C-cells participates in the maintenance of vitally necessary calcium homeostasis. Exogenous calcitonin, as well as a preparation of it, calcitrin, are used mainly in diseases which are accompanied by the phenomena of systemic and local osteoporosis [1].

The peptides participate in the occurrence and induction, and the maintenance and elimination, of pathological processes in the CNS [4, 23]. The clinical and experimental observations attest to a change in the level of the endogenous opioid peptides in patients with schizophrenia, which points to their having a role in the development of mental disturbances [39]. The enkephalins and the endorphins enhance long-term memory, and change the character of eating and drinking behavior [35]. There is information available regarding the role of the peptides in the regulation of the immune system. It has been established [26] that the cells of the immune system, in particular, of the bone marrow, are capable of synthesizing opiates which change the immunologic reactivity of the organism by interacting with specific receptors on the membrane of T-lymphocytes [41]. The authors note that the opiate neuropeptides act as intermediaries between the immune system and the nervous system. Due to the endogenous character of the opioid neuropeptides for the organism, study of the regulatory capacities may hold promise, and the existence of diverse synthetic analogs of them makes possible the carrying out of the appropriate immune correction which is so necessary in the treatment of various pathological disturbances in the presence of altered immunoreactivity in pathogenesis.

The neuropeptides influence the cardiovascular system at the level of the CNS and the effector organs. Thus, the opioid peptides induce bradycardia, which is arrested by naloxone, providing grounds for hypothesizing the stimulation of the vagal influence on the heart by the opioids [48]. The statistically significant decrease in the contractility of the isolated myocardium in the warm-blooded animals under the influence of low concentrations ( $1 \cdot 10^{-9}$  to  $1 \cdot 10^{-8}$  M) of morphine and enkephalin [14, 46] is confirmation of the presence of a zone of opiate binding in the myocardium of mammals. There is information available regarding the participation of the opioid neuropeptides in the pathogenesis of some circulatory disturbances. The relationships between the systemic opioid peptides and other neurotransmitter systems are

disturbed in essential hypertension [29]. The neuropeptides are of great significance in the pathogenesis of arterial hypotension in shock, since the  $\beta$ -endorphins and the enkephalins not only play an important role in the regulatory mechanisms in this type of pathology, but also block the action of the catecholamines on the cardiovascular system [28, 29].

When they analyze the various biological effects of the opioid peptides, the authors frequently point to their modulating effect, i. e., the influence of the enkephalins in various functional conditions on a number of physiological or functional processes can be different and even opposite [25].

The peptides can be used for various purposes in clinical practice. Such peptide preparations as thyroliberin, luliberin, and pentagastrin [21] are used for diagnostic purposes. A number of clinical observations attest to the effectiveness of somatostatin in gastrointestinal hemorrhages, of thyroliberin in acute depressive states and hemorrhagic shock [45], and of cholecystokinin in chronic pancreatitis [50].

The "delayed" effects of the neuropeptides can be used for treatment. For example, a significant local reduction in serotonin content in the brain has been found five days following a one-time administration of a small dose of enkephalins [36]. The length of time the neuropeptides can be found in the blood is usually short; their half-time of elimination lasts only minutes. In this connection, it is possible to achieve a stable high level of peptides in the blood only with constant infusion; however, the possibility of its influence on practical systems of the organism must be taken into account. So broad a spectrum of action of the peptides excludes selectivity of influence on disturbed regulatory links. In this connection, high doses of these preparations should be used for extreme indications, such as the prescription of somatostatin to stop gastrointestinal bleeding [21].

The strategy of treatment with the regulatory neuropeptides should take the features of the influence of these substances on the processes of the life activity of the organism into account: The selective effect of relatively small doses and the presence of "delayed" effects. In addition, the maximal expressivity of the effects in pathological states is characteristic for many neuropeptides. Thus, the opioid peptides have almost no influence on the level of gastrin in the norm, but sharply suppresses its secretion in the presence of stress [33]. The significance of the neuropeptides can be characterized as follows [21]: "The neuropeptides are endogenous substances and their effect in small doses is physiological in character. Therapy with the neuropeptides is an attempt to extricate the organism from the pathological state by means of the administration of 'its own' regulators from without, to break the vicious cycle of the pathological process through the reorganization of the regulatory systems, and their shift to a different level."

Thus, the neuropeptides produced by the cells of the APUD system have a universal character, since they participate in the organization and regulation of all vitally important processes. The adenylate cyclase, cAMP, system serves as their intermediaries or intracellular messengers, as it does in the case of other biologically active substances. The capacity of enkephalins to decrease the cAMP content has made it possible to use them as medicinal agents in some pathological states [13].

The synthesis of the opioid peptides and their synthetic analogs has offered the possibility of utilizing the neuropeptides as medicinal preparations. Clinical testing of a synthetic analog of leu-enkephalin, under the name dalargin, has been going on in our country. A broad preference has been given to opiate receptor blockers of the naloxone type. Information regarding its physicochemical properties, indications and contraindications for its prescription, as well as of the features of its utilization and pharmacological effects has been reported [43, 53].

When dalargin has been used by patients who have experienced a myocardial infarction (MI), it has facilitated the shortening of the time for the normalization of the concentration of lactate, urea, triglycerides, calcium, magnesium, ACTH, and cortisol in the blood plasma [44]. The mechanism of the protective action of the peptides in MI consists in the limitation of the stress injuries to the heart. The concentration of GABA increased by a factor of 2 under the influence of dalargin in the brain of rats in the presence of stress; the content in the blood of the end products of peroxidative oxidation of lipids decreases significantly in MI [25]. The presence of the preparation in the early periods following experimental MI leads to a significant decrease in the dimensions of the necrosis of the heart muscle, that is due to its influence on the survivability of the cardiomyocytes in the peri-infarct zone which are in ischemic conditions [16]. Dalargin has been utilized successfully in clinical practice in the treatment of patients with duodenal ulcer [34].

The anti-ischemic and anti-stress effect of the opioid peptides was the basis for the utilization of the synthetic enkephalins in the comprehensive treatment of occlusive diseases of the lower extremities, in particular, of atherosclerosis obliterans of the lower extremities. In this case—earlier arrest of the pain syndrome, decrease in cold sensitivity of the foot, the disappearance of digital cyanosis, and improvement of rheological parameters are observed. These phenomena may be governed by the antihypoxic effect of the neuropeptides [11, 3, 34, 40]. Data have been presented confirming the capacity of dalargin to prevent disturbances of the cardiac rhythm of the Wolff-Parkinson-White syndrome type.

The authors point to the immunomodulating effect of the opioid peptides, which opens up possibilities for their utilization in the correction of immune disturbances. Thus, the taking of dalargin led to a decrease in

the concentration of immunoglobulins G, A, and M, as well as of the circulation of immune complexes [3, 7, 8].

According to the data of D. S. Everly and R. Rosenfeld [38], the neuropeptides exert a positive effect in the treatment of diseases of the gastrointestinal tract (ulcer disease, ulcerative colitis), of the cardiovascular system (arterial hypertension, arrhythmias, MI, Reynaud's disease), mental disturbances (schizophrenia), experimental models of shock, as well as in the case of immune depression and tumors. The authors did not detect a favorable influence of the neuropeptides in diseases of the respiratory organs (bronchial asthma) and skin diseases (eczema, urticaria, psoriasis).

Pharmacological investigations have shown that dalargin is cleaved into several fragments in human blood, two of which have an opioid structure, and two others for which opioid activity is not characteristic [25]. The data obtained by N. V. Korobov [22] make it possible to regard dalargin and its biologically active metabolites as opioid peptides with primarily peripheral action on the opioid receptors of the visceral organs. The introduction of the neuropeptides into clinical practice, according to the opinion of a number of authors [2, 21, 26], is associated with difficulties. However, it can be asserted that the neuropeptides in medicine are a new class of biologically active substances which play an important role in the treatment of some diseases.

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### Characteristics of Melioidosis Agent Ultrastructure and Its In Vivo Interaction With Phagocytes

907C0719A Kiev *MIKROBIOLOGICHESKIY  
ZHURNAL in Russian Vol 52 No 2, Mar-Apr 90*  
pp 18-22

[Article by S. F. Popov, B. I. Melnikov, V. Ya. Kurilov,  
and V. G. Bozhko, Volgograd Scientific Anti-plague  
Research Institute]

UDC 579.841.11.086.3

[Abstract] In order to understand the pathogenesis of infection, it is necessary to be familiar with the morphology of the microbe both in vivo and in vitro. The goal of this work was to investigate the ultrastructure of melioidosis bacteria in an organism and their interaction with phagocytes during the early hours after infection. Experiments were carried out on guinea pigs that were injected intraperitoneally with *Pseudomonas pseudomallei* strain C-141. Peritoneal exudate was collected at 1, 3 and 6 hrs after infection. By using electron microscopic technique, it was shown that shortly after the infection, three morphologically distinct bacterial variants were formed, one of which was non-encapsulated, one with a microcapsule, and one with a macrocapsule. It was noted that during interaction of these variants with the cells of the host organism, bacteria of the first and second variants were absorbed by phagocytes, while those with the macrocapsule were resistant to phagocytosis and continued multiplying. Figures 2; references 12: 9 Russian, 3 Western.

### Isolation and Characterization of *Yersinia Pestis* Membranes

907C0719C Kiev *MIKROBIOLOGICHESKIY  
ZHURNAL in Russian Vol 52 No 2, Mar-Apr 90*  
pp 39-46

[Article by N. V. Korobeynik, V. S. Tsivin, A. N. Kravchenko, and L. A. Abramova, Scientific Research Anti-plague Institute, Rostov-na-Donu]

UDC 579.842.23.222

[Abstract] The goal of this work was to improve the method of obtaining purified membrane preparations with clear identification of fractions and preservation of the originality of material by using the model of two strains of the plague agent—EV and 556/106. The polypeptide composition was highly heterogeneous as shown by PAAG electrophoresis in presence of sodium dodecyl sulphate and the sensitivity of different protein subunits to temperature variations (28 - 37°C) during cultivation of the agent. It was concluded that a two-stage centrifugation in saccharose gradients makes it possible to perform their separation effectively and rapidly, thereby preserving biochemical and morphological characteristics intrinsic to the preparation of outer and cytoplasmic

membranes. Quantitative and qualitative differences in these structures reflect the specificity of their functions in the cell of plague microbe. A fractionating method was developed for the membrane structures and involved the following steps: Bacterial growth in liquid nutrient medium, mechanical destruction from the solid state in the X-press or treatment of the suspension with ultrasound followed by two stage centrifugation in a step-wise (70 - 15 percent) or linear (70 - 45 percent) saccharose density gradient, followed by collection of the fractions and their storage. Figures 4; references 15: 4 Russian (1 by Western author), 11 Western.

### Metal Leaching From Ores by Silicate Bacteria

907C0735A Kiev *DOKLADY AKADEMII NAUK  
UKRAINSKOY SSR: SERIYA  
B—GEOLOGICHESKIYE, KHIMICHESKIYE I  
BIOLOGICHESKIYE NAUKI in Russian No 5,  
May 90 pp 80-83*

[Article by Z. Rulberg, N. V. Pertsov, S. V. Garbara, S. V. Nechayev, V. G. Stepanenko and V. P. Kiselev, Department of Natural Dispersed Systems, Physico-chemical Institute, USSR Academy of Sciences, Kiev]

UDC 541.183.24:576.8

[Abstract] Trials were conducted on the efficiency of *Bacillus mucilaginosus* in leaching metals from granulated rock containing 90 percent quartz. Data derived after incubation periods of 20 - 40 days showed that the action of *B. mucilaginosus* led to profound changes in the structure of the mineral due to degradation, leaching and solubilization of silicon. In addition, a number of metals were also selectively extracted in the ionic and colloidal states and formation of previously unreported phases was noted. The most commonly encountered phases were represented by Ag+Cu, Fe+Ni, Ag+Zr and Mg+Mn. Since Ag+Zr and Mg+Mn have not been reported in nature, it appears their formation occurs in solution in the course of *B. mucilaginosus* action. Optimum leaching conditions consisted of an incubation time of 20 days in the batch mode, with the mineral salts serving as the nutrient medium. Figures 1; tables 1; references 7: Russian.

### Expression of *Y. pestis* Antigens Encoded by Plasmid pCad

917C0036C Moscow *MOLEKULYARNAYA  
GENETIKA, MIKROBIOLOGIYA I VIRUSOLOGIYA  
in Russian No 6, Jun 90 pp 17-21*

[Article by N. A. Vidyayeva, V. V. Kutyrev, O. A. Protsenko, P. N. Oleynikov and P. I. Anisimov, 'Mikrob' All-Union Scientific Research Anti-plague Institute, Saratov]

UDC 579.843.95:579.252.5].04:546.41].08

[Abstract] An analysis was conducted on the expression of plasmid pCad (temperature-dependence plasmid) genes in *Y. pestis*, and comparison with pCad+ *Y. pseudotuberculosis* and *Y. enterocolitica*. The results demonstrated that on a number of synthetic media and in rabbit, peritoneal exudate synthesis of external membrane antigen encoded by pCad was fully expressed only

in the presence of 20 mM  $Mg^{2+}$ . The expression was equivalent in the three species 18 h after transfer of the cultures from 28°C to 37°C. At 28°C pCad-dependent proteins were not produced. These observations demonstrated that the expression of the pCad antigens is dependent on the  $Mg^{2+}$  concentration, while temperature effects are species-dependent. Figures 5; tables 1; references 35: 4 Russian, 31 Western.



**Localization of Botulin A Structural Gene by Synthetic DNA Probe Based on Light Chain Sequence**

917C0036A Moscow MOLEKULYARNAYA GENETIKA, MIKROBIOLOGIYA I VIRUSOLOGIYA in Russian No 6, Jun 90 pp 11-14

[Article by M. V. Stepanova, N. S. Bystrov, N. V. Servertsova, V. G. Korobko, T. I. Bulatova, T. M. Zubova, V. I. Yevstigneyev, YE. V. Smirnov and Yu. V. Vertiyev, Scientific Research Institute of epidemiology and Microbiology imeni N. F. Gamaleya, USSR Academy of Medical Sciences, Moscow; Institute of Bioorganic Chemistry imeni M. M. Shemyakin, USSR Academy of Sciences, Moscow; Institute of Microbiology, USSR Ministry of Defense, Kirov]

UDC 615.919:579.852.13:579.252].07

[Abstract] DNA sequences were synthesized to correspond to the amino acid sequence of the light chain of botulin A for subsequent use as hybridization probes for localization of the structural gene. Dot hybridization studies on nitrocellulose filters with DNA isolated from *Cl. botulinum* A98, 345 and Memphis and bacteriophage isolates from A98 and Memphis strains showed that the gene was located on the bacterial chromosome and not on the viral replicon. In addition, similar evaluation of DNA isolated from *Cl. perfringens* BP6K revealed homologous regions in the case of the latter as well. This observation is supported by the finding of amino acid sequence homologies among toxins A, B and E and further underscores genetic similarities among the clostridia. Figures 2; references 12: 2 Russian, 10 Western.

**Construction of Transmissible Cointegrates of *Y. pestis* Plasmids pYV and pYT With Plasmid RP4::Mu cts62, IncP1**

917C0036B Moscow MOLEKULYARNAYA GENETIKA, MIKROBIOLOGIYA I VIRUSOLOGIYA in Russian No 6, Jun 90 pp 14-17

[Article by A. V. Rakin and L. K. Kazachenko, Rostov-on-Don Scientific Research Antiplague Institute]

UDC 579.843.95:579.252.55].012

[Abstract] Transmissible cointegrates of *Y. pestis* plasmids pYV and pYT with the broad host spectrum plasmid RP4::Mu cts62 (IncP) were constructed by in vivo recombination and employed in conjugation studies. Cointegrate pKR14 (pYV76oRP4::Mu cts62), 110 Mda, was shown to confer on *Y. pestis*, *Y. enterocolitica* and *Y. pseudotuberculosis* recipients calcium dependence at 37°C, V antigen synthesis, immunity to lysis by phage Mu cts62, incompatibility with the homologous replicon pUV76, and RP4 plasmid markers (Ap<sup>R</sup>, Km<sup>R</sup>, Tc<sup>R</sup>). The cointegrates pKR103 and pKR106

(pYToRP4::Mu cts62), 150 Mda, conferred to recipients the ability to synthesize mouse toxin and Fraction-1 antigen. Similarly, *E. coli* recipients acquired the ability to synthesize the above markers and bacteriophage Mu, but could not transport Fraction-1 antigen to the cell surface. Figures 5; tables 2; references 12: 3 Russian, 9 Western.

**Molecular Studies on Vaccinia Virus. Part 1. Cloning of Vaccinia Virus DNA Fragments in Bacterial Vectors**

917C0103A Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90 pp 962-967

[Article by O. I. Ryazanina, A. V. Totmenin, S. N. Shchelkunov and E. G. Malygin, All-Union Scientific Research Institute of Molecular Biology, USSR Ministry of Medical Industry, Koltsovo, Novosibirsk Oblast]

UDC 578.821

[Abstract] The importance of vaccinia virus for construction of live recombinant vaccines led to preparation and cloning of HindIII fragments of the DNA of vaccinia strain L-IVP, widely used in the USSR for vaccination. The HindIII fragments were inserted into plasmid vector pBR322, resulting in a series of plasmids designated pVH bearing all of the fragments with the exception of HindIII fragments B, G and A. The large HindIII A-fragment was cloned into cosmid pHC79 and amplified in *E. coli* DH1 to give a bank of DNA molecules bearing the large A fragment. Hybrid plasmids carrying fragments of vaccinia virus DNA may serve as vectors for introduction of foreign DNA into the vaccinia virus genome, as well as gene donors for engineering bacterial hosts for production of viral proteins. Figures 3; tables 1; references 14: 7 Russian, 7 Western.

**Molecular Studies on Vaccinia Virus Genome. Part 2. Localization and Nucleotide Sequence of Genes Encoding Proteins 36K and 12K**

917C0103B Moscow MOLEKULYARNAYA BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90 pp 968-976

[Article by O. I. Ryazankina, S. N. Shchelkunov, A. I. Muravlev, N. A. Netesova, N. N. Mikryukov, V. V. Gutorov, A. Ye. Nikulin, V. A. Kulichkov and E. G. Malygin, All-Union Scientific Research Institute of Molecular Biology, USSR Ministry of Medical Industry, Koltsovo, Novosibirsk Oblast]

UDC 578.821

[Abstract] Mapping studies were conducted on the late 36K and 12K genes of vaccinia virus L-IVP, with determination of their nucleotide sequence and comparison of the respective 36 kD and 12 kD proteins with a protein sequence data bank (PIR). The late genes are an

area of special interest since they are located in a conservative region of the vaccinia genome and evidently crucial to viral development. Hybridization selection of late mRNA and HindIII DNA fragments revealed that the 36K and 12K genes were located in HindIII P-fragment. DNA-DNA hybridization studies demonstrated that the origin of the 36K gene falls within the J-fragment obtained with HindIII cleavage. Protein comparison demonstrated considerable homology between the 36 kD protein and NADH-ubiquinone-oxidoreductase and (2'-5')oligo(A)-synthase, and between 12kD protein and helix destabilizing protein and dihydrofolate reductase. Figures 6; references 25: 2 Russian, 23 Western.

**Molecular Studies on Vaccinia Virus Genome.  
Part 2. Identification of Late Gene 36K Product  
Located in HindIII-P Fragment of Vaccinia Virus  
Strain L-IVP**

917C0103C Moscow MOLEKULYARNAYA  
BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90  
pp 968-976

[Article by O. I. Ryazankina, S. N. Shchelkunov, A. I. Muravlev, N. V. Cheshenko, N. A. Chikayev and Z. G. Malygin, All-Union Scientific Research Institute of Molecular Biology, USSR Ministry of Medical Industry, Koltsovo, Novosibirsk Oblast]

UDC 578.821

[Abstract] An immunochemical analysis was conducted on the 36 kD protein encoded by the late 36K gene of vaccinia virus following its cloning in plasmid vector pUR290 and expression in E.coli. The product consisted of a chimeric protein of  $\beta$ -galactosidase with the 36 kD sequence representing the C-terminus. The fusion protein displayed viral specificity in immunochemical studies. Additional studies demonstrated that the 36 kD protein is not a component of the vaccinia virion per se, but of the plasma membrane of vaccinia virus-infected cells. The 36 kD protein is synthesized late in the replicative cycle in large quantities and may be important in viral assembly. Figures 6; tables 1; references 12: 2 Russian, 10 Western.

**Expression Unit in Initiation Region of  
Streptococcal Plasmid pSM19035**

917C0103D Moscow MOLEKULYARNAYA  
BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90  
pp 993-1000

[Article by A. V. Sorokin and V. E. Khazak, All-Union Scientific Research Center of Genetics and Selection of Industrial Microorganisms, Moscow]

UDC 579.252.58:577.214.625:577.13.5

[Abstract] An analysis was conducted on the 'expression unit', EU<sub>19035</sub>, of plasmid pSM19035 isolated from

*Streptococcus pyogenes* and used for transformation of *Bacillus subtilis*. The nucleotide sequences of the plasmid bearing the promoter and the initiation site have been shown to be similar to those of *Bacillus*. Accordingly, a minimal pSM19035 replicon was engineered for expression in *B. subtilis*, incorporating a *Bacillus amyloliquefaciens*  $\alpha$ -amylase gene lacking a promoter, an (tab) $\lambda$ cI857 gene with BamHI site upstream to ATG initiator codon. The engineered *B. subtilis* produced 0.5 g/L of  $\alpha$ -amylase and the  $\lambda$ -repressor protein in an amount equal to 3 percent of the total intracellular soluble protein. The repressor was fully functional in *B. subtilis* vis-a-vis phage  $\lambda$ P<sub>R</sub> promoter. Additional plasmids bearing EU<sub>19035</sub> were constructed (pARK11 and pCB22) with well-defined restrictase maps for use in a wide spectrum of Gram positive bacteria. Figures 6; references 12: 1 Russian, 11 Western.

**Genus-Specific DNA Probe for Yersinia Detection**

917C0103E Moscow MOLEKULYARNAYA  
BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90  
pp 1010-1016

[Article by G. G. Dikhanov and O. N. Podladchikova, Scientific Research Anti-plague Institute, USSR Ministry of Health, Rostov-on-Don]

UDC 579.842.23+575.222.7+577.217.34

[Abstract] Technical details are presented on the construction of a genus-specific DNA probe for the identification of *Yersinia*. The basic approach utilized reverse transcriptase for the synthesis of a double-stranded DNA complementary to the 5'-end of *Y. pestis* 16S rRNA. Fragments of the putative DNA probe were cloned in plasmid vector pUC19 and amplified in *E. coli*. Recombinant clones and plasmids were then cross-hybridized with P-32 labeled 16S rRNA of *E. coli* and *Y. pestis*. Plasmid DNA binding specifically to the *Y. pestis* 16S rRNA was isolated and shown to possess DNA complementary to the V1 variable region of *Y. pestis* 16S rRNA. Further hybridization studies demonstrated that the V1 region is identical in *Y. pestis*, *Y. pseudotuberculosis*, *Y. enterocolitica*, *Y. kristensenii* and *Y. intermedia*, and that such DNA probes are truly genus-specific. Figures 4; tables 1; references 18: 2 Russian, 16 Western.

UDC 579.254.2

**Transformation of Cotton Plants (*Gossypium hirsutum*) by Supervirulent *Agrobacterium tumefaciens* A281**

917C0103F Moscow MOLEKULYARNAYA  
BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90  
pp 1017-1023

[Article by Ye. V. Revenkova, A. S. Krayev and K. G. Skryabin, Institute of Molecular Biology imeni V. A. Engelhardt, USSR Academy of Sciences, Moscow]

[Abstract] Studies were conducted on the transformation of cotton plants (*Gossypium hirsutum*), employing cocultivation of cotyledons derived from 12-day old shoots with *Agrobacterium tumefaciens* A281. Supervirulence of *A. tumefaciens* A281 is attributed to the presence of the supervirulence plasmid pTiBo542, which ensures a frequency of transformation some ten-fold higher than obtainable with the more commonly employed *A. tumefaciens* LBA4404. The *A. tumefaciens* A281 bore, in addition, plasmids pBII101 and pBII21 bearing the NPTII (kanamycin kinase) gene responsible for imparting kanamycin resistance. The resultant galls grew on media containing 25 mg/L kanamycin, with optimum growth and frequency of transformation enhanced on agarose MS medium. The gall tissue exhibited kanamycin kinase activity. In addition, Southern blot hybridization was used to demonstrate the presence of NPTII gene in the plant genome, further confirming the transgenic nature of the cotton plants. Figures 2; tables 2; references 20: 2 Russian, 18 Western.

#### Improved Sanger Sequencing

917C0103G Moscow MOLEKULYARNAYA  
BIOLOGIYA in Russian Vol 24 No 4, Jul-Aug 90  
pp 1095-1099

[Article by A. S. Krayev and V. N. Mironov, Institute of Molecular Biology imeni V. A. Engelhardt, USSR Academy of Sciences, Moscow]

UDC 577.113.5

[Abstract] Conventional Sanger sequencing was further improved by growth of the engineered M13 bacteriophage in disposable polypropylene test tubes and by carrying out the polymerase reaction in microtitration wells. In addition, the level of label was reduced 5- to 10-fold by quasi-end labeling of the newly synthesized DNA chains with low-energy P-33 radionuclide. This technique involved synthesis of labeled chains until dNTP was depleted, followed by second synthesis for elongation of the chains until the terminator was incorporated. The use of P-33 yielded very sharp electrophoretic patterns equal to or exceeding the resolution obtained with S-35 labels, while requiring only overnight exposure with conventional x-ray film. These modifications reduced the cost of Sanger sequencing, minimize radiation hazard and offer a greater choice in the selection of label and DNA polymerase. Suitable reagents are available from 'Biopol' Scientific Industrial Center in Moscow and the 'Vektor' Scientific Industrial Association in Novosibirsk. Figures 1; tables 1; references 8: 2 Russian, 6 Western.

**Effects of T Activin on Thymic Morphology in Experimental Lower Extremity Trauma: Stress-Alleviation**

917C0038A Moscow BYULLETEN  
EKSPERIMENTALNOY BIOLOGII I MEDITSINY  
in Russian Vol 109 No 6, Jun 90 pp 585-587

[Article by N. I. Kovalskaya, V. N. Arion and V. N. Blinkov, Scientific Research Institute of Physicochemical Institute, RSFSR Ministry of Health; 2nd Moscow Medical Institute imeni N. I. Pirogov]

UDC 617.58-001-092.9-06:613.863]-085.361.438-036.8-07:616.438-076

[Abstract] Femoral fracture studies were conducted on 17.5 - 19.0 g male (CBA x C57BL/6)F<sub>1</sub> mice to assess the effect of T-activin on stress-induced thymic involution. Histological assessment of the thymus demonstrated that s.c. administration of 1.0 µg of T-activin 1 day before the fracture or immediately after attenuated and arrested involutionary changes, and promoted recovery of normal thymic morphology over the subsequent 5 - 15 days. Concomitantly, T-activin was also observed to promote bone healing. These findings provide additional support for the protective role of T-activin vis-a-vis the thymus. Figures 1; references 15: 6 Russian, 9 Western.

**Dalatsin C (Turkey)**

917C0128C Minsk ZDRAVOOKHRANENIYE  
BELORUSSII in Russian No 10, Oct 90 p 82

[Description presented of novel antibiotic; BSSR Production Association]

[Abstract] Dalatsin C (synonym: clindamycin) is effective on gram-positive cocci (staphylococci and streptococci, but not enterococci), some gram-positive bacteria (*Clostridium* and anthrax microbes), non-spore forming anaerobes (*Bacteroides* and *Fusobacterium*), and *Mycoplasma*. It is not effective on fungi, viruses, or protozoans, except *Toxoplasma*. Its mechanism of action is similar to that of lincomycin and is used with the same indications as the latter, but is two to ten times more effective. It is administered intravenously and intramuscularly in doses ranging from 150 - 450 mg every 6 hours to manage respiratory infections, sepsis, wound infections, osteomyelitis, etc. Dalatsin C is generally well tolerated with the most frequent complications consisting of gastrointestinal disturbances, rashes, hives, and itching. Caution must be exercised when administering this drug to asthmatics or those with a history of allergic reactions.

**Effect of Angiotensin II on Blood Plasma Catecholamine Content in Rats**

907C0802 Leningrad FIZIOLOGICHESKIY  
ZHURNAL SSSR IMENI I. M. SECHENOVA  
in Russian Vol 76 No 4, Apr 90 pp 486-491

[Article by A. A. Bonetskiy and V. I. Fedorov, Laboratory of Hormonal Studies, Kirgiz Scientific Research Institute of Ecology and Prevention of Infectious Diseases, Frunze]

UDC 612.118.2+612.814

[Abstract] The effect of a short-term (5 min) and extended (40 min) IV infusion of angiotensin II on the level of circulating catecholamines was investigated on experimental rats during the passage of blood through the small blood circulating circle. The reagent was infused through a catheter into the right atrium. A five-minute infusion of angiotensin II (at 0.1, 0.3 and 1.0  $\mu\text{g}/\text{kg}/\text{min}$ ) significantly raised the level of plasma norepinephrine in an inverse ratio to the administered dose; the levels of adrenaline and dopamine were also elevated, but not significantly. With increased dosage, the difference in arteriovenous levels of norepinephrine dropped to 17.4, 7.2 and 0.1 percent, in comparison to the control level of 21.8 percent. The 40-min infusion of 1.0  $\mu\text{g}/\text{kg}/\text{min}$  of angiotensin II resulted in a lower plasma level of norepinephrine without affecting the difference in the arteriovenous levels. An assumption was made that the capture and inactivation of circulating norepinephrine in the lungs represents one additional level of the effect of angiotensin II on the sympathetic adrenal system. References 12: 5 Russian, 7 Western.

**Effects of Bombesin and Bombesin Analogs on Secretion and Pepsin and HCl Content of Gastric Juice**

917C0066B Leningrad FIZIOLOGICHESKIY  
ZHURNAL SSSR IMENI I. M. SECHENOVA  
in Russian Vol 76 No 7, Jul 90 pp 903-912

[Article by G. M. Barashkova, P. K. Klimov, I. L. Kuranova, S. I. Churkina and Ye. B. Filonova, Laboratory of Renal Physiology and Water-Salt Metabolism, Institute of Evolutionary Physiology and Biochemistry imeni I. M. Sechenov, USSR Academy of Sciences, Chair of Chemistry of Natural Compounds, State University, Leningrad]

UDC 612.323:577.15/.17

[Abstract] Outbred 20 - 25 kg dogs with Pavlov pouches were employed in a study on the effects of bombesin and bombesin congeners on the production of gastric juice and its pepsin and HCl content. Infusion studies demonstrated that i.v. administration of 2 or 5  $\mu\text{g}/\text{kg}/\text{h}$  of bombesin after a 200 g raw meat meal diminishes secretion of gastric juice and its HCl content for 30 - 60 min in comparison with the results in bombesin-untreated animals. Simultaneous infusion of pentagastrin and bombesin (2  $\mu\text{g}/\text{kg}/\text{h}$ ) attenuated secretion and lowered the HCl concentration for 90 - 120 min, following which secretion and HCl production was enhanced. Con-infusion of histamine and bombesin (2 or 5  $\mu\text{g}/\text{kg}/\text{h}$ ) increased HCl production over the level observed with histamine alone. Finally, microapplication of 10  $\mu\text{g}$  of bombesin to the amygdala and the caudate nucleus concomitantly with i.v. histamine diminished secretion and HCl production for 90 - 110 min by 50 - 70 percent.

### Increased Newborn Illness, Death in Altay Kray Linked to Environmental Pollution

907C0515A Moscow TRUD in Russian 24 Mar 90 p 2

[Article by correspondent O. Khripunov: "A Cruel Lesson: Why Children Are Sick and Dying in Altay"]

[Text] The first question young mothers ask fearfully of their doctor after giving birth is this: "Is the child alive, and is it yellow?" Alas, they have something to be fearful of. Last year the Kray newspapers reported a sharp (tenfold) increase in the incidence of hemolytic jaundice and an even greater rise in afflictions of the central nervous system among newborn infants in the city of Gornyak, Loktevskiy Rayon. Upon going there, I learned that 12 children have already died, and dozens of others are being given multiple blood transfusions.

Many sought the causes, but no one ever found them. Kray health department assistant director V. Belousov reported that average background concentrations in Gornyak's soil were exceeded by a factor of 9 for lead, 13 for cadmium, 40 for copper, and 100 for zinc. But after all, such contamination is rather typical of the entire Kray. The doctors supposed that a lingering fire that occurred a few months earlier in the mine, which had almost suffocated Gornyak with toxic gases, might have affected the health of the pregnant women. Or could the proximity of the Semipalatinsk test range have had an effect? Or perhaps the toxic chemicals stored in totally impermissible conditions and in huge quantities at the rayon agrochemical association's storage site, right inside the city, poisoned the people just like the insects?

Nor were the specialists from Barnaul, Novosibirsk and Moscow institutes that composed a special medical team from the RSFSR Ministry of Health able to identify the invisible assassin. Its report leads to the vague conclusion that everything taken together had supposedly played the critical role.

You can imagine the state of a pregnant woman who awaits a dead, sick or deformed child with an almost 100 percent guarantee. Is there any forgiveness for a society guilty of such a thing? A society which is unable to find the causes or rectify the situation? Large numbers of children are being born with a standard set of defects when it is supposedly known for certain that this is not an epidemic—there is no infection, after all—this causes terror. What is left for the people to do—to hope for God's mercy? Maybe He heard the prayers, causing widespread illness in Gornyak to decline. Many probably crossed themselves in relief.

But... The epidemic flared up with new force in the town of Yarovoye, Slavgorodskiy Rayon, and then in Talmenkiy Rayon, adjacent to Novosibirsk Oblast. These population centers are hundreds of kilometers from Gornyak and from one another. What ill winds carried tragedy here? Specialists searching for the causes of the children's illnesses covered their ground a second time, and a third time. And in the meantime young mothers

continue to give birth to yellow-complexioned children, though this was far from the worst that could happen.

"The grayish, dirty green hue of jaundice and the marbling of the skin were obvious," the doctors say in the report. "Boys are encountered twice as frequently among the patients." A comatose state was documented among some children. People in the town of Yarovoye look with fear and hatred at the Altaykhimprom Association located here, associating the misfortunes with it, probably justifiably. It is due to glasnost that the fact became known that over a period of several days carbon tetrachloride, which poses an extreme health hazard, was supplied together with hot water to each apartment in the town. But in Talmenka—the third focus of disease—there are neither chemical combines, nor mines, nor test ranges, and yet it was precisely there that the most intense pathology was observed.

"We have already had as many as 22 deformed births in the last few months," said L. Bakalova, the assistant to the chief physician for childhood and maternity at the rayon hospital, on the verge of tears.

Infant mortality and the number of stillborn children and deformed children is growing in Talmenka, which had always been thought to be a healthy place. Over 100 youngsters afflicted with jaundice, anemia and central nervous system disorders have already emerged into the world.

"The most terrible thing is that we don't know why they become stricken with jaundice," complained L. Bakalova.

Neither a toxicologist from Sverdlovsk, nor a professor from the Jaundice Center, nor a virologist from Moscow was able to answer this question. Specialists found themselves helpless once again. And here is the point of view expressed by rayon executive committee deputy chairman L. Pyatkova:

"For a long time now all the vegetables we have been growing—cucumbers and tomatoes—have been beneath a film. Otherwise everything turns yellow and black. We have long been accustomed to seeing sulfurous accumulations in puddles. It's terrifying to imagine what we are drinking, what we are eating and what we are breathing in our bountiful kray..."

An across-the-board decrease in life span is apparently only a small price paid to nature for its careless handling. But in Altay Kray, the price has been even higher—the lives of infants and the health of nursing children.

I. Voyennova, assistant to the chief physician of the rayon epidemiological center, told me that Talmenka epidemiologists have detected mercury in pork, nitrates in vegetables, phenol in water, and zinc in cheese, and all of these in quantities significantly exceeding the norms. And finally, hexafluorane, a toxic preparation used in agriculture, has been detected in mother's milk. Its concentration is especially high among mothers with

children suffering from jaundice. Where did it come from? I found the answer to this question in an official document, a decision of the Talmenskiy Rayon Executive Committee. It declares: "Seventy-four tons of 23 kinds of toxic chemicals have accumulated in the rayon; among them, there are chemicals which are totally prohibited or with an expired shelf life... Toxic chemicals are stored with the grossest violations. There is free access to the poisons, they are stored in heaps, unpackaged...in the path of spring water runoff." Does this mean that an entire rayon has decided to put an end to itself? To make matters worse, this is not a problem of just a single rayon: the situation in it is rather typical. The entire kray is gradually undergoing degradation, its deforestation is continuing, natural soil fertility is declining, toxic substances are being discharged into the atmosphere and water basins, a burial site for toxic industrial wastes is lacking....

Yes, contrary to common sense we are continuing to worsen the situation, we are poisoning ourselves and our children, and we are entering into an ever-increasing conflict with nature, with no solution in sight. We have essentially arrived at a process of degrading the population—we are bringing dead, deformed and jaundiced children into the world. What awaits us in the future, a generation of mutants? And what is it that could hold us back, and force us to finally open our eyes? Even after hundreds of yellow children appeared in Altay Kray, people are still campaigning for construction of the Katunskaya Hydroelectric Power Station, the reservoir of which will cover mercury deposits. Another sinister warning appeared in Barnaul—balls of mercury were discovered in the tapwater of some of the homes of its citizens. And once again the source is unknown.

It looks like Siberia's ecology, which has been thrown off balance, will not be able to endure any more "projects of the century." Nature's cup of patience runneth over, and the gentlest nudge would be enough to cause a most unpredictable cataclysm to occur just about anywhere...

In Talmenka I visited a young mother, Tatyana K., who gave birth to a jaundiced boy a few months ago. After several blood transfusions and hospital treatment in the kray center, her Volodya appeared to be a fully healthy child. But even if his childhood illness does not affect his health in the future, life for him in the poisoned country would hardly be happy and peaceful.

We asked G. A. Samsygin, the chief pediatrician of the USSR Ministry of Health, to comment on this news from Altay: "The situation in Altay Kray is alarming, and unfortunately not an isolated one. Mothers and children are the first to suffer in an ecologically unfavorable situation. We were convinced of this when we encountered the numerous cases of chemical disease in Chernovtsy and in the Aral region. But the specific manifestations of disease are different everywhere. It depends on precisely what chemical substances are acting in what combinations. The situation is extreme—after all, out of the thousands of chemicals placed into production each

year, only dozens are tested for carcinogenic, toxicological and genetic effects! The country doesn't even have a catalog of the chemical substances and compounds it produces; the fact that hygienic standards are absent is a small problem in comparison. Sooner or later we must be punished for such negligence in our attitude toward our health and the destiny of future generations.

"It is still too early to say precisely what will be discovered in Altay Kray, inasmuch as the commission from the RSFSR Ministry of Health, which is reinforced with hygienists, toxicologists and hematologists from Leningrad, Sverdlovsk, Kiev and Moscow, is still working. Increased destruction of erythrocytes is observed in the presence of chemical intoxication, and the liver suffers, unable to perform its function. The kidneys, the gastrointestinal tract and the respiratory and endocrine systems may also become afflicted. Nonetheless, the main conclusion can already be made: Everything we encountered in Altay, in Chernovtsy and in the Aral region and everything we have yet to encounter attests to but one diagnosis—truly suicidal tendencies in the behavior of a society which is reluctant to make sure that new production procedures are safe before pressing the start button. 'Buttons' are not going to help us restore mankind's health."

#### Pharmaceutical Plants to be Built With Foreign Aid

907C0515B Moscow PRAVDA in Russian 23 Mar 90  
p 8

[Article by Yu. Stepanov: "Medicines? No Problem!"]

[Text] Fulfilling instructions of the Congress of People's Deputies, the USSR Council of Ministers asked the USSR Ministry of the Medical Industry to build four pharmaceutical plants with the assistance of foreign companies and have them ready for full operation by 1993.

"They must provide our sector with a significant increase in products satisfying the demands of international standards," said Deputy USSR Minister of the Medical Industry V. Romanenko. "One of these plants, which is to be built in Gorkiy Oblast, will begin manufacturing synthetic medications. Among them there will be cardiovascular, gastric, psychotropic and various children's medicinal preparations which are not being produced in adequate quantities in our country today."

Novokuznetsk was identified as the location of another plant. Broad-spectrum antibiotics will be produced here. The future plant is oriented on production of new generation anti-inflammatory preparations.

The amount of insulin we produce is five times less than what we need. The USSR Ministry of Health buys some of it abroad, spending considerable amounts of hard currency in doing so. Another plant, which we will build in Leningrad Oblast, will completely satisfy the demand of our public health for this scarce medicine.

And finally, the building of a plant manufacturing a wide assortment of vitamins that are especially necessary in times of major viral outbreaks will begin in Tomsk.

Each of these plants, which are ecologically harmless to the environment and the population, will have a production volume of 200 - 250 million rubles per year.

The pharmaceutical plants are to be equipped with automated and computerized systems. Over 20 foreign companies, including some from England, Italy, France, the USA, the FRG, Finland and elsewhere, have expressed a desire to compete for participation in their building. In the immediate future we will study all of the proposals submitted to us in detail, in order to determine which company we will sign a mutually profitable contract with. The one that offers the lowest bid for building a given plant and will employ modern procedures and equipment will win.

### Problems of Iron-Deficiency Anemia in Kazakhstan Population

907C0790A Moscow VOPROSY PITANIYA in Russian  
No 3, May-Jun 90 pp 13-15

[Article by T. A. Izmukhambetov, Kazakh Ministry of Health, Alma-Ata]

UDC 616.155.194.8-036.22(574)

[Text] Soviet health care is geared toward prevention, and for that reason tests aimed at the identification and correction of background conditions that help the development of the most widespread diseases are very important. One problem that has not received proper attention until recently is iron-deficiency anemia, which is widespread in the most vulnerable segment of the population—infants and women. Analysis of data in the literature indicates that the incidence of anemia and iron deficiencies is very high in that population group in many countries. Laboratory-confirmed forms of anemia are encountered in 21.8 percent (Polish People's Republic) to 82 percent (Burma) of pregnant women.<sup>5</sup> Iron-deficiency states determined on the basis of iron saturation of transferrin are even more widespread and are found in 40 - 99 percent of pregnant women. According to the estimates of the same team of researchers,<sup>8</sup> iron-deficiency states are noted in an average of 43 percent of infants.

A similar situation exists in a number of regions of Kazakhstan. Analysis of statistical records shows that almost 20 percent of the pregnant women in the republic have overt forms of anemia. There is a stable trend toward a rise in the incidence of anemia in that population contingent (13 percent in 1986, higher than 18 percent in 1988). Spot epidemiological checks in a number of the republic's oblasts with high morbidity and mortality indicators revealed that the incidence of hypochromic anemia among women of child-bearing age

is 46 percent, whereas latent forms of iron deficiency are encountered in almost 70 percent of the tested women.

Against such a background, an increase in the incidence of other diseases is also noted. For example, renal disease was recorded in 4.9 percent of the women who visited obstetric-gynecological clinics in 1987, and in 6 percent in 1988. In the same period, the maternal mortality rate rose to 0.46/1000 births from 0.37. There was a 1.7-fold increase in the number of maternal deaths due to septic complications caused by inadequacy of the body's immune system which, as we know, is depressed when there is an iron deficiency.<sup>7</sup>

In addition, a high child mortality rate persists in the republic. At the present time, that indicator is 29/1000 births, and an overt link to the incidence of anemia is demonstrable. It has been noted that anemia was diagnosed in almost 70 percent of the pregnant women whose infants die before the age of one year. In such cases, the high percentage of hypogalactia (32 percent) also has an adverse effect on infant health. A higher incidence of septic complication is observed in regions where anemia among the female and infant population is encountered more frequently. If the average figure for the republic for septic complications as the cause of death is 8.3 percent of all infant deaths, that figure is 19 percent or higher in regions with a high incidence of iron-deficiency states. A one and a half to threefold rise in incidence of septic complications was noted for the analyzed period in Kzyl-Orda, Kustanay and Chimkent oblasts.

A number of researchers<sup>6, 7, 9</sup> note that immunity is depressed in the presence of iron deficiency and that, as a result, there is a one and a half to twofold rise in incidence of respiratory and intestinal diseases in infants. Illnesses in that very group are one of the main causes of child mortality in the republic.<sup>1</sup> Analysis of data in the literature,<sup>12, 14, 15</sup> indicates that presence of even moderate forms of iron-deficiency states leads to a rise in maternal and perinatal morbidity and mortality, work efficiency declines appreciably, and absenteeism due to temporary disability increases.

The data that have been presented are indicative of a definite correlation between incidence of iron-deficiency states and health indicators in some population groups of the republic. However, that aspect of the problem has not been investigated deeply enough in the republic, and it requires further analysis for the purpose of ascertaining cause-and-effect and correlation factors.

Diet is known to play the leading role in development of iron-deficiency states,<sup>10</sup> and iron-deficiency anemia is the most widespread form of anemia.<sup>2, 3</sup>

Investigation of the actual diet of the population revealed that in regions with the highest morbidity and mortality rates, 90 percent, at most, of the protein requirements are met. Animal protein intake is under 70 percent of the recommended allowance, which is indicative of a substantial lack of sources of the biologically



most accessible iron in the public's diet. Only 45 - 50 percent of the requirements for animal protein and no more than 20 percent of the requirements for vitamins A and C are met in Kzyl-Orda Oblast, and it is those essential nutrients that play a substantial role in preventing anemia.<sup>11, 13</sup> For that reason, it is not surprising that almost one-third of the pregnant women in that oblast suffer from overt forms of anemia.

Estimates of vitamin intake in food and laboratory testing of vitamin levels (assays of vitamin concentration in blood of nursing mothers) are indicative of a significant deficiency in vitamins A, E, and C and the B group, the levels of which are 30 - 40 percent below what is recommended.

If the mother's diet is not satisfactory, her milk may be inadequate (in terms of both quantity and quality). As a result, in some of the republic's regions, only 50 - 90 percent of protein requirements are met in breast-fed infants six months of age or under, as are only 70 - 90 percent of those for fats, only 70 - 80 percent of those for carbohydrates, and only 70 - 80 percent of those for energy. In addition, there is a shortage of baby food.<sup>1</sup> We cannot help but mention the poor ecological conditions of several regions of that republic (particularly those adjacent to the Aral Sea), the shortage of potable water, high degree of mineralization of that water, and the pollution of the environment by pesticides, i.e., factors that have a deleterious effect on the human body and prevent assimilation of dietary iron.<sup>2-4</sup> All of the above are instrumental in promoting iron-deficiency states in pregnant and nursing women, predisposed children to the development of such states, and have a substantial effect on the health of that population group.

The problem of improving the health of the republic's population should be dealt with by optimizing and improving the structure of public nutrition, implemented thorough health screening and identification of risk groups for anemia, to be followed by appropriate treatment, including specialized foods.

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#### Economic Evaluation of Fluorographic Verification Studies in Identifying Lung Cancer

907C0830B Leningrad VOPROSY ONKOLOGII  
in Russian Vol 36 No 5, May 90 pp 572-575

[Article by I. P. Komyakov, N. N. Blinov, A. S. Neyshstadt and O. V. Lovyagin, Order of the Labor Red Banner Scientific Research Institute of Oncology imeni Professor N. N. Petrov, USSR Ministry of Health, Leningrad]

UDC 616.24-006.6:616-073.756.5:33:003.13

[Abstract] According to WHO recommendations, it is not advisable to carry out prophylactic screening for lung cancer because of the excessive monetary costs. An opposing view, however, holds that postponing or limiting such screening immediately results in fewer individuals diagnosed in an initial stage of cancer and more diagnosed in later stages. An attempt was made to evaluate the cost-effectiveness of fluorographic screening for lung cancer. It has been established that a single fluorogram costs about 0.29 +0.01 ruble in the USSR, when salaries, plates, reagents, and rent and overhead are considered. A case was made for single frontal exposure, since the side exposure provided only information supportive of a diagnosis already made. Overall, the cost of detecting a single case of lung cancer was found to be 1318.2 rubles. But other diseases have also been detected in the process—tuberculosis, nonspecific diseases of the lung—and when that is taken into consideration, the cost of the detection of lung cancer drops to 18.8 rubles. It was concluded that a dual exposure (frontal and lateral) was not advisable for the detection of lung cancer, while the frontal view was totally justified both economically and medically. References 8: 3 Russian, 5 Western.

### Space Radiation Safety Center Opens

907C0673B Moscow NTR TRIBUNA in Russian  
No 7-8, 1990 p 11

[Interview with Ye. Ye. Kovalev, doctor of technical sciences State Prize laureate, Meritorious Scientist of the RSFSR, and acting director of the Scientific Research Center for Radiation Safety of Space Facilities, by D. Dmitriadi, NTR TRIBUNA correspondent, under the rubric "We Report the Details": "What Risk is Justified?"; first two paragraphs are source introduction]

[Text] **The Scientific Research Center for Radiation Safety of Space Facilities in Moscow at a sector of the Institute of Biomedical Problems of the USSR Ministry of Health.**

The acting director of the center, Doctor of Technical Sciences Ye. Ye. Kovalev, a State Prize laureate and Meritorious Scientist of the RSFSR, tells our correspondent D. Dmitriadi about the objectives of the center.

"We have been working in the area of radiation safety for people on space flights for a long time," said Yevgeniy Yevgenyevich. "Its foundations lie in a conversation with S. P. Korolev. At that time, on the threshold of manned space flight, he and N. Ryzhov, a specialist in radiobiology, suggested that we listen to their ideas of a radiation dose that would not threaten the health of an individual in space.

"At first we were afraid of the radiation which arose as a result of solar flares. But after the measurements that were made on the first orbital spacecraft, it became clear that the effect of those flares on the radiation conditions inside a spacecraft during short-term flights was insignificant.

"In subsequent investigations it was found that the heterogeneities of the magnetosphere of the Earth presented a much greater danger to an individual's life. The fact is that the effect of the radiation belts along a flight path is nonuniform. Near the north and south magnetic poles and also in the region of the so-called South Atlantic Anomaly, the magnetic force lines are so near the surface of the Earth that the spacecraft passes through proton fluxes. For those fluxes, the magnetic force lines serve, as it were, as axes along which the fluxes move. It is on those very segments of the orbit that the cosmonauts receive the main radiation dose. As for the effect of those fluxes on the human body, it should be said that they present the most danger to the bone marrow, the liver, and the gonads. In the absence of appropriate protection measures, proton beams are capable of causing radiation sickness in man. And neutron flows are no less dangerous.

"The following fact characterizes the effectiveness of the solutions we have come up with for ensuring the safety of the cosmonauts: the radiation dose of the fifth main expedition aboard the Mir space station was a total of about 10 rem over a period of the six months of the

mission, and about 2.2 rem were from the October solar flares. I should say for comparison that a man on the surface of the Earth receives a dose of 0.5 - 0.6 rem over that same period.

"On the other hand, even that small a radiation dose can lead to adverse effects in the human body. The attempt to reduce the radiation levels aboard a spacecraft to background levels was doomed to failure: the mass of the spacecraft would have to be tens or hundreds of tons, and putting it into orbit would simply be impossible. But just how low would the intensity of the radiation aboard the spacecraft have to be brought down to? Not too long ago it was felt that no dose was so small to be considered absolutely safe. But then Professor Yu. Planel from the National Space Research Center (France) ascertained that only with the presence of ions in the human body (and they appear in response to flows of charged particles) do metabolic processes take place normally in the body. If man is artificially insulated from the natural radiation background, some natural mechanism, which is responsible for his adaptability to external factors is, as it were, "switched off" in him.

"Thus, a dilemma confronts us; on the one hand, complete radiation safety for space flights cannot, in principle, be attained, but, on the other hand, the danger, it would seem, is not so great as to completely halt flights into space. Where is the boundary that separates a justified risk from an unreasonable one? The theory of 'acceptable risk' that we developed answers that question."

[Dmitriadi]: Please explain that in a little more detail.

"First of all, we need an accurate definition of the concept itself of risk. Thus, we must resort to its mathematical evaluation and to take risk to mean the probability of an undesirable event, a probability that can be found in the mortality statistics among given groups of a population for various reasons: as a result of disease, accidents, natural disasters, etc. On the basis of such an analysis, we have been able to ascertain, for example, the following: for a young man aged 25, the probability of death as a result of an accident is approximately 2.2 times greater than from disease. That is primarily associated with his limited amount of life experience. On the other hand, for a man over 60, the risk of dying from an accident is much less than from disease. The values of those two quantities are close to each other somewhere in the age range of 30 - 40. If, moreover, cosmonauts are screened for the corps from physically healthy people, then the risk of death for the cosmonauts over a year's time from disease is 1,000 lower than that for "ordinary" people of the same age."

[Dmitriadi]: But exactly what criterion is chosen to determine the magnitudes of acceptable risk?

"Two methods exist for determining that magnitude. The first approach is based on the idea of the minimization of losses. If we cut down on safety, then the possible losses stemming from the fact that the risk is not

equal to zero increase. It is possible to reduce them by spending money on ensuring safety, but then the financial expenses increase. In that case, it is worth analyzing the sum of the possible losses at various values of risk. That is how we find the value of the reliability of a given device for which the minimum of the sum of losses is ensured in accomplishing the assigned goal.

"The other approach is based on ensuring a sufficient psychological acceptability of voluntary risk. In real life, people frequently compare intuitively the possible loss from a risk and the benefit from a given action. The level of voluntarily accepted risk exceeds the level of mandatory risk by hundreds or even thousands of times. For example, automobile trips in a large city are tens of times more dangerous than are aircraft flights; but for some reason, many of us look on aviation with great mistrust. Another aspect of the psychological acceptability of risk comes into play here—the difference between an old, "customary" risk and a risk associated with some new part of one's life."

[Dmitriadi]: If we're speaking of the psychological aspects of the introduction of new technology, then can't the following question come up: if the sum of the risks steadily increases as a result of the appearance of new equipment, then how on earth can people be convinced that the next "addition" to the sum total of the risks is acceptable?

"The situation that exists in reality differs considerably from such a simplified model: after all, we must still take into account the interrelationship among the different factors of risk. Thus, for example, the hour-and-a-half flight by airplane from Leningrad to Moscow is associated with, of course, a certain risk. But really, doesn't that mode of travel remove, all at once, all the risks associated with surface travel over long distances: the risk of becoming sick on the road, of getting into a highway accident, etc.? Consequently, some risks come to replace other risks. Moreover, one of the factors which attests to the usefulness of a given type of technology for man is not only the simple substitution of risks, but the general reduction in the total risk. A consequence of that reduction that confirms that should be the increase in the average lifespan of the group of people who constantly used that technology. And that will mean that we are on the right path.

"While we were developing protection for the cosmonauts against cosmic radiation, we also succeeded in obtaining certain results and designs that are of independent value. That, for example, is how the 'human phantom' was created—a full-scale model that made it possible to measure the radiation doses accumulated both in the entire human body as well as in its most important individual organs. Similar 'phantoms' are now widely employed in the testing of passenger aircraft.

"Some of our work is helping people on the "ground" level. The research associates of the sector have created high-voltage meters that operate on the electrostatic

principle. The equipment that was used earlier on satellites for measuring the radiation background we are planning to install on a dirigible for performing low-altitude remote sensing of the Earth. I especially want to mention a chamber for the radiation testing of large-scale equipment. It was erected for working out the design of the Buran spacecraft. Now the European Space Agency is thinking about leasing it from us for similar testing of its own mini-shuttle Hermes. Thus, the center can count on a considerable income in foreign currency."

"In concluding this conversation, I would like to mention that space flights, no matter how banal this sounds, are engines of progress. And if we do not want to find ourselves in the role of those perpetually trying to catch up, then, with all our everyday difficulties, it is not worth skimping on branches of science and technology that will return investments a hundred-fold tomorrow."

#### **Development and Structure of Optic Nerve Following Exposure to Large Doses of Ionizing Radiation**

917C0128A Minsk ZDRAVOOKHRANENIYE  
BELORUSSII in Russian No 10, Oct 90 pp 29-31

[P. I. Lobko and I. P. Stepanova, Chair of Human Anatomy, Minsk Medical Institute]

UDC 612.014.482:617.731]-092.9

[Abstract] The development of the optic nerve and its membranes in human and murine embryogenesis was investigated to determine the sequelae of X-ray irradiation on the formation of these structures in murine embryogenesis. Preliminary data were obtained from 75 human embryos and fetuses and 54 rat embryos, fetuses, and newborns ranging in age from 10 days of intrauterine development to birth. Experimental data obtained from 77 rat embryos and fetuses whose mothers were irradiated with 2.24 Gr at days 10 - 14 of the pregnancy demonstrated that optic nerve development in rats was quite similar to that of humans. The findings also demonstrated that ionizing radiation is hazardous to optic nerve development, causing hypoplasia and aplasia of the nerve trunk, aberrations in the growth of nerve fibers with their subsequent reduction, and delays in the formation and differentiation of the nerve sheath. Figures 5; tables 1; references 9: 5 Russian, 4 Western.

#### **Heavy Metals in Soil in Minsk**

917C0130A Minsk DOKLADY AKADEMII NAUK  
BSSR in Russian Vol 34 No 9, Sep 90 pp 838-840

[Article by V. K. Lukashev, corresponding member Belorussian SSR Academy of Sciences, and L. V. Okun, Geochemistry and Geophysics Institute, Belorussian SSR Academy of Sciences]

UDC 631.416.8(476)

[Text] The specific "urban environment" that man lives in is characterized by a great deal of new, often extreme living conditions that seriously affect public health and occupational fitness.

Scientific investigations have unambiguously established that the incidence of diseases of the respiratory organs and cardiovascular system and cancers are significantly higher in cities than in rural areas. Changes in the chemical composition of the environment have resulted in the spread of new diseases—genetic, toxicologic, allergic, and endocrine. Along with pollutants that have been investigated for a long time (dust, carbon monoxide, carbon dioxide, oxides of sulfur, nitrogen and phosphorus, and toxic chemicals); researchers are paying ever increasing attention to heavy metals. Heavy metals are currently considered to be the main source of every possible disorder in biological systems. They afflict various organs and augment the development of malignant tumors. Disturbances in environmental element concentrations are especially hazardous to children.

In the Laboratory of Supergenesis Geochemistry, complex investigations have been performed for several years on the environmental status of a number of industrial cities in the republic [1-3]. The purpose of this paper is to assess the content of heavy metals in the soil in Minsk.

The city is characterized by a very high concentration of industry and transportation, and a high density of housing development as a result of extensive economic development. During the post-war years, the city's population has increased approximately six times, while during this same period the volume of industrial production has risen more than 100 times. Branches of scientific and technical progress (engineering, radioelectronics, instrument engineering, power engineering, etc.) have experienced the greatest development. These same branches also have a negative effect on the environment and public health. The ecological problems in the city have become more aggravated in recent years.

We assessed the content and distribution of heavy metals in the city's soil in order to characterize the status of the city's environment. Investigation of the soil is extremely important in studying the technogenic changes in the city's environment. The soil has been collecting technogenic substances during the entire period of the city's existence and characterizes the general geochemical situation of a given territory.

Metals in the surface layer of the soil have the greatest effect on man inasmuch as 50 - 60 percent of the dust in the atmosphere near the earth originates from the soil.

We collected samples (sampling density—one sample per kilometer) from the upper ten-centimeter layer of soil. Emission spectral analysis was employed to calculate the content of 40 elements. Based on the data

obtained, we constructed a series of mono- and polyelemental maps of metal distribution in municipal soils.

The elements in question were divided into three groups by content and nature of distribution:

- 1) elements that result in high-contrast abnormalities confined to certain industrial areas (mercury, bismuth, tungsten, cadmium, silver, and chrome);
- 2) elements that accumulate throughout the entire city that often result in high-contrast abnormalities (lead, zinc, copper, and manganese, nickel, and cobalt to a lesser degree);
- 3) elements that do not result in pronounced abnormalities at this level of development of the city's environment, and that are found in the city's soils in quantities close to baseline levels (gallium, niobium, strontium, scandium, beryllium, zirconium, etc.).

We divided the city into regions by the level of heavy metal soil pollution. The abnormalities detected differed in the composition of the pollutant elements and their concentrations. Lead and zinc that enter the city's environment primarily from automobile exhausts were found in all of the abnormal areas. Four areas in the city were found to have a high degree of soil pollution (figure).

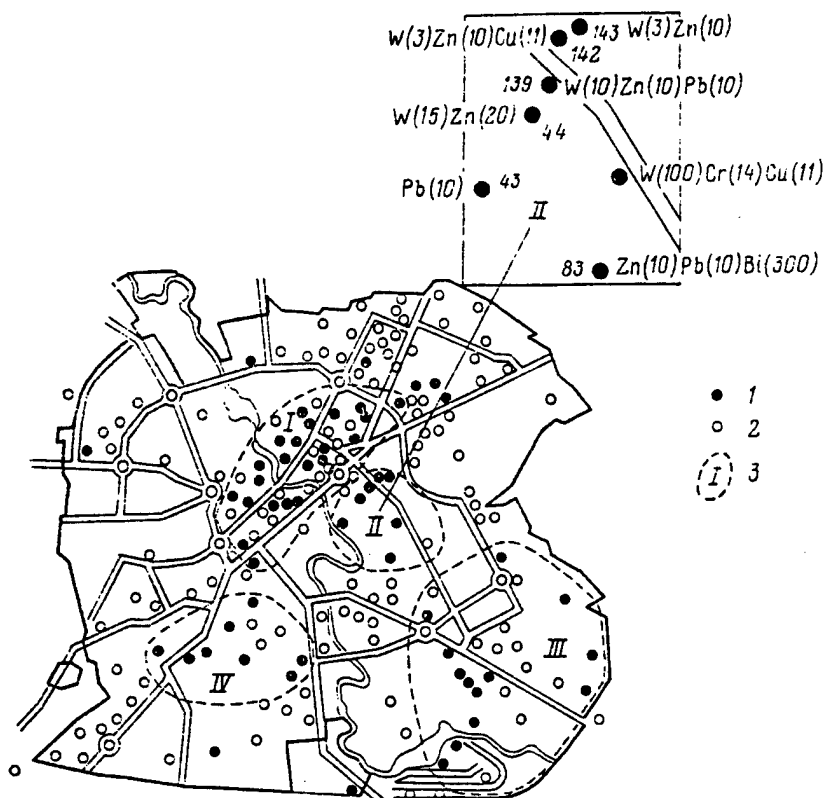
Zone 1. Lead, zinc, and copper are among the abnormalities here. Lead and zinc are the chief elements in this association. This pollution zone encompasses the older region of the city, its center. The main source of soil pollution in this region is many years of heavy transportation traffic.

Zone 2 is illustrated in more detail by the inset map to the Figure. The typical pollutant metal in this section is tungsten, the concentration of which at point 36 exceeds the normal level by 100 times. At other sample collection points the content of the element is lower and varies from 3-15 times higher than the normal level. In addition to tungsten, this area has elevated concentrations of zinc, lead, and copper.

Zone 3 encompasses the greater part of the Zavod Rayon of the capitol. The chief pollutant elements are mercury and zinc, with lead, copper, manganese, chrome, and nickel as secondary pollutants.

The formation of these two pollution centers is due to the high concentration of commercial production in the industrial region of the city (foundry engineering, metal processing, etc.).

Zone 4. Lead and zinc, with locally high concentrations of silver, copper, chrome, and vanadium, make up the abnormal conditions in this area. The pollution zone encompasses the airport and the territory adjacent to it. We associate the formation of this technogenic anomaly with the exhaust products of aviation and automobile engine combustion as well as the wastes of the industrial enterprises located here.



**Figure.** Distribution of heavy metals in soil in Minsk. Sample collection depth 0-10 cm. 1. Collection point with abnormal metal content; 2. Collection point with normal metal content; 3. Boundary and number of abnormal zones of soil contamination; W(15)Zn(20) abnormal element association. In the parentheses is the amount of metal concentration above the normal content.

We assessed the technogenic pollution of the soil in Minsk on a scale of ecological hazard of soil pollution with metals based on calculations of total pollution indices [4, 5].

According to the suggested gradation, the soil in Minsk is quite heterogeneous in its metal content. It ranges from normal to extremely dangerous. Only 18.7 percent of the city can be considered acceptable in its heavy metal concentration, 41.7 percent is moderately hazardous, 33.7 percent is hazardous, and 5.7 percent is extremely hazardous.

The investigations demonstrated that in the city, especially in its industrial regions, a complex polyelemental pollution center is forming. Industrial enterprises, transportation, and thermal power plants are its sources. The various enterprises form specific abnormalities that differ in their degree of concentration and association of chemical elements.

In assessing the pollution of the city's soil, it might be noted that the most hazardous areas of the city in a health respect are the eastern and south-eastern parts of Minsk, as well as the region with the old developments,

the administrative center. In the residential areas located on the periphery of the city, the level of soil pollution is generally acceptable.

Dividing the city of Minsk into regions by the level of soil pollution with heavy metals may serve as the basis for health control, rational planning decisions, and measures for cleaning up the environment. These investigations are the first stage in studying the environmental status of the city. Large-scale systematic investigations on a special program are needed.

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### Geochemical Aspects of Strontium-90 in Soil-Water System

917C0130B Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 34 No 9, Sep 90 pp 841-844

[Article by V. A. Kuznetsov and V. A. Generalova, Geochemistry and Geophysics Institute, Belorussian SSR Academy of Sciences]

[Text] An index of radionuclide migration in the topography and transformation from technogenic to natural compounds is the form they are in. Studies [1-8] and other investigations discuss problems associated with researching various forms. However, clarification of the regional mechanisms of their distribution and migration in a soil-surface water system remains a problem in radiogeochemistry that has not been well-investigated and needs to be solved on a general theoretical basis as well as in a practical respect in connection with actual topographic-geochemical circumstances.

We studied the distribution of strontium-90 and cesium-137 and their forms in river sediments and various types of soil in southern Belorussia (Braginskiy Rayon) during global fallouts and following the accident at the Chernobyl Nuclear Power Station. The following forms of compounds were isolated: exchange-sorption, calcareous, bound with an organic substance, sorbed onto sesquihydroxides, and difficultly soluble.

In global pollution the total strontium-90 content in peat-bog soils is  $2.3 \times 10^{-10}$  mg/m<sup>3</sup>, with approximately 50 percent of the radionuclide in readily exchangeable forms. The amount of calcareous and organogenic compounds and compounds bound with amorphous hydroxides ranges from 10 to 15 percent, while rigidly bound compounds make up 20 percent of the radionuclide content. Following the accident, the relative quantity of exchange-sorption compounds was five times lower and the amount of organogenic and chemisorbed forms increased. Difficultly soluble forms (Figure, a and b) composed about half of the radionuclide content, while the strontium-90 content was  $2.4 \times 10^{-7}$ . A similar phenomenon is observed in the distribution of strontium-90 in alluvial-sod soils and river sediments. The quantity of readily soluble compounds in the former is 70 percent, while rigidly bound compounds make up about 15 percent. At the same time the amount of difficultly soluble material increased to 40 percent in the samples collected after the accident. The content of

rigidly sorbed forms also increased while the relative content of readily exchanged forms significantly decreased (Figure, c-e).

Comparison of the cesium-137 forms in the soils with contaminants from global and accidental pollutants also indicated, like for strontium-90, an abrupt rise in the fixed compounds (to 90 percent) with a low content of readily soluble compounds. In contrast to radioactive strontium, cesium-137 does not bind with a natural organic substance in practice. Correlation analysis of the relations of the concentration of radioisotopes with basic soil components in the global fallouts confirms this (Table 1, 1984). Whereas strontium-90 exhibits a close correlation with organic material and calcium at a level

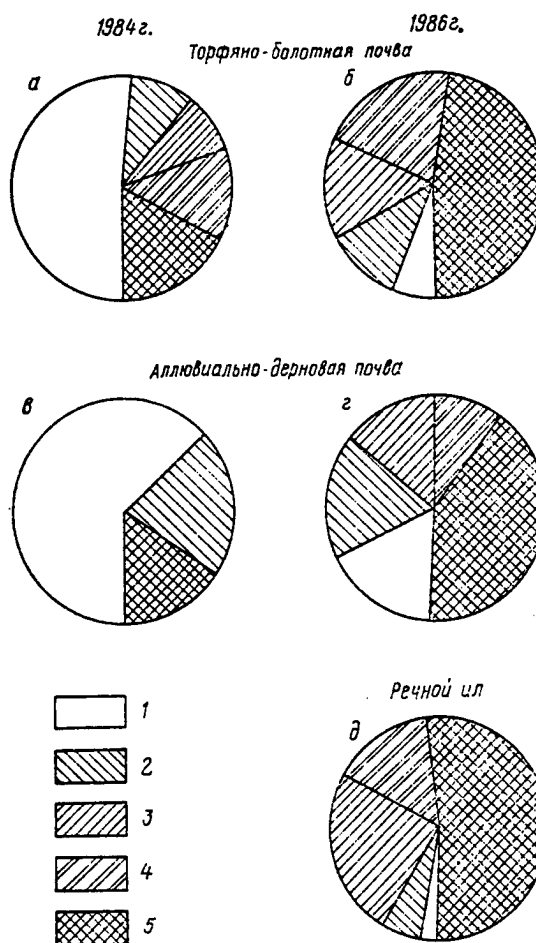


Figure. Distribution of forms of strontium-90 in soils and river sediments: 1. exchange; 2. calcareous; 3. organic; 4. sorbed on  $R_2O_3$ ; 5. difficultly soluble.

Key:  
1. Peat bog soil  
2. Alluvial-sod soil  
3. River

of significance of  $p = 0.001$ , cesium-137 is only attracted toward the mineral part of the soil.

**Table 1. Correlation factors between strontium-90, cesium-137, and basic soil components.**

Component	OB	Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub> +SiO <sub>2</sub>	CaO
<b>1984, n = 25</b>				
Strontium-90	0.80+0.13	0.48+0.15	0.75+0.15	0.74+0.15
Cesium-137	0.32+0.19	0.59+0.17	0.65+0.17	0.59+0.17
<b>1986, n = 17</b>				
Strontium-90	0.29+0.43	0.40+0.41	0.06+0.45	0.13+0.44
<b>1988, n = 12</b>				
Strontium-90	0.40+0.29	0.44+0.28	0.40+0.29	0.25+0.31
Cesium-137	0.09+0.31	0.39+0.29	0.38+0.29	0.34+0.29

We calculated the correlation factors of the radioisotopes with respect to the basic components of the soil with pollution from the accident for a more detailed comparative description of the sorbing capabilities of the soil (Table 1, 1986 and 1988). After the accident there are practically no correlation connections, but two years later an elevation is observed in the sorption strength of the radionuclides by organic matter, amorphous hydroxides of iron, and clay material. It should be noted that during the 8 years of reaction of cesium-137 with the soil, the amount of rigidly bound compounds increased by 1.5 times [9].

The radionuclide forms have decisive significance in predicting their transition from the soil into the surface water, migration along the soil profile, penetration into ground water, and precipitation on geochemical barriers. This primarily relates to soluble compounds. In spite of the relatively great factual data on the mobile forms of strontium-90, its behavior in calcareous compounds in nature remains poorly researched and needs detailed study. During the first year following the Chernobyl accident, the concentration of calcareous strontium-90 in the soils reached 15 - 30 percent of the total radionuclide content and gradually decreased by June 1988 to 1.5 - 2 times the normal content. This resulted from the reaction of strontium-90 from the accidental outburst into the atmosphere with water vapors and carbon dioxide (which formed after the dissociation of dolomite, which was added to the reactor to contain the accident) and partial conversion into bicarbonate or calcareous compounds. When falling to the earth, these compounds were redistributed in the soil and included in the geochemical cycle of migration.

**Table 2. Average Chemical Composition of Natural Water and Calculated CO<sup>2-3</sup> and SR<sup>2+</sup> Ion Concentration Equilibrium**

Component	Water, mg/l			
	Surface	Soil, ground	Upper peat-bogs	Lower peat-bogs
pH	7.7	6.7	4.4	6.7
HCO <sup>-3</sup>	216.8	165.8	7.9	187.7
Cl <sup>-</sup>	6.8	11.1	5.6	5.1
SO <sup>2-4</sup>	7.2	11.7	0.6	8.0
Ca <sup>2+</sup>	53.7	42.8	3.6	46.8
Mg <sup>2+</sup>	10.9	10.0	0.6	9.7
Na <sup>+</sup> +K <sup>+</sup>	7.1	9.5	0.9	4.2
m*CO <sup>2-3</sup>	10 <sup>-4.96</sup>	10 <sup>-6.07</sup>	—	10 <sup>-6.14</sup>
mSr <sup>2+</sup>	—	10 <sup>-3.63</sup>	10 <sup>-0.1</sup>	10 <sup>-3.56</sup>
n**	47	83	14	46

\*m is the number, g-ion/l; \*\*n is the number of samples.

Assuming that the behavior of radionuclides in natural systems is determined by the chemical properties of the isotope-carrier, we attempted to assess the migrational properties of calcareous strontium-90 on the example of its stable isotope. Based on chemical analysis data of the various types of natural water, we calculated the strontium ion concentration in solution in equilibrium with strontianite. As is known, the behavior of a calcareous mineral in solution is regulated by its solubility product, pH, and cation activity, and is a function of the equilibrium ratios of the calcareous ions.

We used the Debye-Hueckel equation [10] to first calculate the ionic strength of a solution and the activity coefficients of Sr<sup>2+</sup>, Ca<sup>2+</sup>, and CO<sup>2-3</sup>. The solubility product of CaCO<sub>3</sub> was taken as lgSP = 8.32, and it was lgSP = 9.96 for SrCO<sub>3</sub> [11]. Table 2 presents the results of statistical processing of hydrochemical analyses (average data) of the surface, soil/ground, and peat waters from various regions of Belorussia and a theoretical calculation of the equilibrium concentration of Sr<sup>2+</sup> and Ca<sup>2+</sup> ions which suggests that all the natural waters with a pH of less than 7 and Ca<sup>2+</sup> content of less than 50 mg/l leach the Sr<sup>2+</sup> cation (up to 20 mg/l) from the crystalline phase of SrCO<sub>3</sub>. Considering the better mobility of strontium-90 in comparison with the stable isotope [6], it might be concluded that all swamp and soil/ground waters would leach the strontium-90 ion from calcareous compounds into solution.

The aspects of the geochemical behavior of the radioactive strontium in question in a soil-water system might be used in investigating the migration of radionuclides in river valleys. Flood plain soil is of interest as one of the geochemical barriers. It is interesting as a supergenic chemical and mineralogic conversion of material introduced into the topography of a number of watersheds—rivers—the terminal discharge reservoirs. The strontium-90 carried from the watersheds accumulates in ferruginized horizons. Secondary concentration of the radioisotope here is due to coprecipitation with iron,

which usually accumulates with the change in the redox potential and acid-base balance on the soil border, the surface and flood river waters. The accumulation of radioactive strontium due to solution of its calcareous compounds by soil/ground and peat waters plays an important role in this.

Thus, investigation of the forms of radionuclides reveals: 1) differences in the nature of the composition of global and accidental entry of radionuclides into the environment, which is fundamental to understanding their migration in the topography; 2) the beginning of transformation of technogenic (accidental) forms in natural conditions; and 3) one of the aspects of radioactive strontium migration following accidental entry into the Belorussian river valleys.

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#### Effect of Cesium-137 Incorporation on Cytoenzymology of Rat Peripheral Blood Lymphocytes

917C0131A Minsk *DOKLADY AKADEMII NAUK BSSR in Russian Vol 34 No 9, Sep 90 pp 853-855*

[Article by A. P. Ambrosyev, G. G. Vereshchako and A. O. Kedrov, Radiation Biology Institute, Belorussian SSR Academy of Sciences]

UDC 577.391+612.112.94+599.323.4

[Abstract] Albino male rats (220 - 260 g) were employed to research the effects of a low dose of cesium-137 (1.6 MBq/kg) on oxidation-reduction enzymes in peripheral blood lymphocytes. The animals were administered 0.1 MBq/kg of cesium-137 per day for 16 days. Radiation measurements indicated that at day 30 of the experiment, 0.147 Gr had been incorporated, and by day 360 that value increased to 0.2605 Gr. Analysis of the effects of cesium-137 on oxidation-reduction enzymes in the lymphocytes demonstrated that by the end of the experiment (day 360) cytoplasmic  $\alpha$ -glycerophosphate dehydrogenase,  $\alpha$ -oxoglutarate dehydrogenase,  $\beta$ -hydroxybutarate dehydrogenase, and succinate dehydrogenase activity had returned to baseline levels, while lactate dehydrogenase activity remained elevated. Depression of glucose-6-phosphate and glutamate oxidation activity reflects a change in carbohydrate metabolism and a decrease in lymphocyte antioxidant function for the former and a decrease in glutamate participation in bioenergetic cellular processes for the latter. These results suggest that the lymphocytes are apparently adapting to the cesium-137-induced changes. Figures 1; references 7: Russian.

#### Changes in Cardiovascular System Based on EKG Data in Workers Who Participated in Cleanup Operations After Chernobyl AES Accident

917C0279 Moscow *GIGIYENA TRUDA I PROFESSIONALNYYE ZABOLEVANIYA in Russian No 10, Oct 90 pp 3-6*

[Article by L. I. Kovaleva, P. N. Lyubchenko and Ye. B. Dubinina, Moscow Oblast Scientific Research Institute of Cardiology imeni M. F. Vladimirovskiy, Moscow]

UDC 613.648-07:616.12-073.97

[Abstract] Changes in the cardiovascular system were evaluated from EKGs taken on 122 workers who participated in cleanup operations after the Chernobyl accident. That group consisted of 116 men and 6 women, aged 19 - 58. Clinical examinations showed the following: 61 had cardiovascular system irregularities (47 had vegetovascular dystonia; 10, hypertonic disease; 2, ischemic heart disease; 1, dilatational cardiomyopathy; and 55, gastrointestinal tract disorders that consisted mainly of chronic gastritis). Only two individuals were deemed essentially healthy. To exclude the vagal influence on the myocardium upon EKG, orthostatic atropine and ephedrine tests were performed. The subjects exhibited dysfunctions of the autonomic nervous system. Weakened response to atropine and ephedrine was thought to be the result of secondary vagotonia caused by decreased sensitivity of  $\beta$ -adrenergic receptors. These data should be taken in consideration when treating such individuals—in no case should  $\beta$ -adrenergic blockers be administered. References 9: Russian.



**Interaction of N-Terminal Peptide of Influenza Virus Light Chain Hemagglutinin (HA<sub>2</sub>) and Human Immunodeficiency Virus Transmembrane Glycoprotein (gp41) With Artificial and Natural Lipid Membranes**

907C0779B Moscow *BIOLOGICHESKIYE MEMBRANY* in Russian Vol 7 No 3, Mar 90 pp 261-273

[Article by V. A. Slepshkin, G. B. Melikyan\*, M. V. Sidorova\*\*, G. V. Kornilayeva, V. M. Chumakov, A. A. Azmuko\*\*, S. M. Andreyev\*\*, A. E. Kalmanson, and E. V. Karamov, Institute of Virology imeni D. I. Ivanovskiy, USSR Academy of Medical Sciences, Moscow; Institute of Physiology imeni L. A. Orbelya, Armenian SSR Academy of Sciences, Yerevan; Institute of Immunology, USSR Ministry of Health, Moscow]

UDC 578.233.22

[Abstract] Synthesized peptides corresponding to the N-terminal sequence of influenza virus light chain

hemagglutinin (HA<sub>2</sub>) and the transmembrane glycoprotein (gp41) of human immunodeficiency virus (HIV) strain BRU were tested for their interactions with artificial and natural lipid membranes. Peptide III (522-532 gp 160 HIV, strain BRU) induced a stepwise increase in the conductivity of phosphatidylcholine:choline bilayer lipid membranes (BLM) at 37°C. A similar increase was obtained with HA<sub>2</sub> at pH 5.2. Ca<sup>2+</sup> reduced the increase in conductivity by approximately 50 percent but had no effect on incorporation of the peptides into the BLMs. Peptides IV (524-538 gp 160) and II (517-538 gp 160) also increased conductivity of liposomes, with peptide II also inducing membrane fusion at 37°C, pH 7.4. Every HIV peptide in that sequence, otherwise inactive, inhibited HIV-induced syncytia in LAV-I cell cultures with an efficiency directly proportional to peptide length. Peptide II, which was most efficient in this respect and represented the entire length of gp41, also caused the cells to lyse in a concentration of 1 mM. The key observation in this study was the identification of peptide II as the factor leading to membrane fusion in vitro. Figures 11; tables 3; references 33: 2 Russian, 31 Western.

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